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DETACHMENT OF THE CHOROID AFTER CATARACT EXTRACTION

CLINICAL AND EXPERIMENTAL STUDIES, WITH A REPORT OF SEVENTY-FIVE CASES

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Detachment of the choroid commonly follows cataract extraction, but it is apparently infrequently recognized and is rarely mentioned in the literature. Detachment is believed to occur almost invariably at the time of operation, but it may occur or recur during convalescence or, in rare instances, even later.

INCIDENCE

H. Knapp,[1] in 1868, was the first to report detachment of the choroid after cataract extraction; the clinical diagnosis was sarcoma, but microscopic examination of the enucleated eye revealed only an elevated choroid under which there was an accumulation of serous fluid. During the next thirty-two years only ten additional cases [2] were recorded, but in 1900 Fuchs [3] published an account of six cases, all of which were seen within a period of seven months; he gave the incidence as 4.7 per cent of all extractions and expressed the belief that the complication was not rare but was simply overlooked. The report of another case was published by Augstein,[4] in 1901; another by Meller,[5] in 1912, and an additional one by Verhoeff,[6] in 1915. Barkan,[7] in 1920, reported a large series of cataract extractions, with detachment of the choroid in approxi-

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From the Department of Ophthalmology, State University of Iowa College of Medicine.

Read at the meeting of the American Ophthalmological Society, Hot Springs, Va., June 6, 1935.

1. Knapp, H.: Die intraocularen Geschwülste, Karlsruhe, C. F. Müller, 1868.

2. (*a*) Reuling: Arch. f. Augenh. **1**: 186, 1869. (*b*) Groenouw: ibid. **20**:69, 1889. (*c*) Haab: Beitr. z. Augenh. **1**:103, 1893. (*d*) Lindemann: ibid. **1**:338, 1893. (*e*) Marshall, C. D.: Detachment of the Choroid, Tr. Ophth. Soc. United Kingdom **16**:98, 1896. (*f*) Velhagen: Centralbl. f. Prakt. Augenh. **21**:363, 1897.

3. Fuchs, E.: Arch. f. Ophth. **51**: 199, 1900.

4. Augstein: Ztschr. f. Augenh. **5**: 268, 1901.

5. Meller: Arch. f. Ophth. **80**: 170, 1912.

6. Verhoeff, F. H.: Ophth. Rec. **24**: 55, 1915.

7. Barkan, H.: Postoperative Detachment of the Choroid, J. A. M. A. **65**: 1520 (Oct. 30) 1915.

mately 4.5 per cent of the cases. Hagen,[8] in an interesting article which appeared in 1921, reported eleven detachments in a series of fifty consecutive cataract extractions, an incidence of 22 per cent. It was only by careful study and clear recognition of the signs of detachment that so many were found.

The present study is based on observations of seventy-five cases of detachment of the choroid, all of which followed uncomplicated cataract extractions. Detachment was noted in fifty cases from the first to the seventh day after operation, but recently ophthalmoscopic examinations have been made immediately after operation, and in twenty-five cases, i. e., in almost every case in which the details of the fundus were visible, a flat detachment of the choroid was found. It followed intracapsular extraction in sixty-two cases, attempted intracapsular extraction in which the capsule ruptured in the late stages of delivery of the lens in four cases and extracapsular extraction in nine cases. It may be stated that the nine cases of extracapsular extraction were attempted intracapsular operations, but the capsule ruptured before the zonule was torn, and to all intents and purposes the extractions were made by the extracapsular method. Age and sex apparently had no bearing on the incidence, the ages ranging from 44 to 85 years inclusive and males and females being equally affected. The exact incidence is unknown, since all cases of cataract extraction were not carefully studied immediately after operation and during convalescence. However, the condition is exceedingly common and excites little comment in the clinic. It is believed that separation of the choroid occurs at operation in almost every case, but it is impossible to determine the exact incidence, since, as a result of blood, air or cortical material in the anterior chamber, the fundus is not always visible at this time. In those cases in which the fundus can be seen immediately after operation, choroidal detachment is almost invariably found.

ETIOLOGY

Many theories as to the etiology have been expressed. Knapp [1] believed that the fluid accumulated as a result of plastic scleritis. Gouvéa,[9] from an experimental study on dogs, considered detachment to be the result of a transudate, following loss of the lens and vitreous. Reuling [2a] thought that a vacuum was formed in the suprachoroidal space following loss of the lens and vitreous. Groenouw [2b] was of the same opinion but believed that a predisposition existed. Haab [2c] thought that the "pseudotumors" were cysts in the peripheral retina. Lindemann [2d] stated that the appearance was due to a swollen blood-stained lenticular rest which was displaced backward into the vitreous.

8. Hagen: Klin. Monatsbl. f. Augenh. **66**: 161, 1921.

9. Gouvéa, quoted by Meesmann: Arch. f. Augenh. **90**: 69, 1922.

Marshall [2e] found active serous exudation under the choroid. Velhagen [2f] believed that after puncture of the anterior chamber vesicles such as those described by Greef formed in the epithelium of the ciliary body and gave rise to the appearance of pseudotumor. Fuchs [10] thought that elderly persons with hard inelastic sclerae were predisposed to choroidal detachment; he attributed the condition to loss of aqueous, rupture of the ligamentum pectinatum, contraction of the choroid with the creation of negative pressure in the suprachoroidal space and sucking backward of the aqueous through the rupture into the suprachoroidal area. Transudation also was believed to occur. Meller [5] had a somewhat different opinion. He believed that loss of aqueous was followed by reduced intra-ocular pressure, with transudation from the vessels of the ciliary body and loss of fluid from the vitreous; the fluid collected under the ciliary epithelium, but eventually the pressure in this area became so great that the fluid flowed more easily into the suprachoroidal space and thus detached the choroid. Hudson [11] and Barkan [7] believed that the detachment resulted from reduction of intra-ocular pressure and transudation of fluid from the choroidal vessels, probably the veins.

Hagen [8] described the mechanism of detachment as follows: The anterior chamber was emptied, and ordinarily the aqueous was replaced by fluid from the vitreous. However, if the wound did not close rapidly and seepage of the aqueous continued, the vitreous could not refill the eye. Continued loss of fluid from the vitreous resulted in loss of volume and negative pressure, with a pull on the retina and choroid; the choroidal vessels were congested, and a transudate formed between the loosely connected choroid and sclera. When the wound closed the vitreous fluid was replaced from the ciliary body. Meesmann [12] made experimental studies on rabbits and believed that the detachment was the result of loss of volume and pressure in the eye, with transudation from the vessels of the ciliary body and capillaries of the choroid. Verhoeff [13] considered the cause to be the result of transudation of fluid from the choroidal vessels, following opening of the eye and reduction of the intra-ocular pressure to almost zero. This fluid distended the suprachoroidal space and compressed the vitreous. The persistence of the detachment after healing of the wound showed that fluid had been squeezed out of the vitreous.

Many of the aforementioned theories follow similar lines of thought; i. e., the detachment occurs with lowering of the intra-ocular pressure and subsequent transudation of fluid into the suprachoroidal space.

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10. Fuchs, E.: Arch. f. Ophth. **53**: 375, 1901.

11. Hudson, R.: Ophth. Hosp. Rep. London **19**: 301, 1914.

12. Meesmann: Arch. f. Augenh. **90**: 69, 1922.

13. Verhoeff, F. H.: Pathogenesis of Glaucoma, Arch. Ophth. **54**:20 (Jan.) 1925.

The ciliary body and choroid are loosely attached to the sclera by delicate suprachoroidal lamellae, except at the scleral spur, in the region of the venae vorticosae and at the posterior pole. The attachment is especially loose in the region of the ciliary body and anterior choroid. The long, thin suprachoroidal lamellae run outward and backward in an extremely oblique manner, from an inward attachment to the ciliary body and choroid to an outward scleral attachment. Consequently in these regions direct attachment of the choroid and sclera is almost negligible. The numerous large veins in the anterior choroid have exceedingly thin walls; in fact, they appear as large blood sinuses enclosed only by a single layer of endothelial cells (fig. 1). So far as can be determined, there are no perivascular lymph spaces; at least no second layer of endothelial cells can be observed. No muscular coat is present, and the connective tissue fibrillae surrounding the blood sinuses in this region are thin and form only a loose meshwork. From microscopic studies of three enucleated normal human eyes and the eyes of monkeys fixed in vivo by perfusion through the ascending aorta,[14] it appears that the suprachoroidal space contains small amounts of albuminous fluid and therefore must be a normal lymph space (figs. 2, 3, 4 and 5). The intra-ocular vessels are normally under a comparatively high tissue pressure (20 mm. of mercury). However, the hydrodynamic pressure inside the vessels is sufficient to provide for normal exchange of fluids between the blood and tissues. When the globe is opened the tissue pressure outside the vessels is greatly reduced and, as a result of the relative increase of pressure inside the thin-walled veins there is rapid and exaggerated transudation of fluid. The rigid sclera tends to maintain its normal shape and contour, even though the globe is opened, but the normal pressure exerted by the vitreous is reduced and the non-rigid ciliary body and thin anterior choroid are more easily forced inward by the collection of fluid in the suprachoroidal space. All the changes just mentioned indicate the probable mechanism of detachment; i. e., with a sudden reduction of intra-ocular pressure there is congestion and a relative increase of pressure in the thin-walled choroidal veins or blood sinuses, distention of their walls and transudation of the fluid elements of the blood into the choroid and suprachoroidal lymph space.

14. Monkey eyes were fixed in vivo by perfusion through the blood vessels. Under sodium amytal anesthesia the crystalline lens was extracted by the usual extracapsular technic. Immediately after extraction the left side of the chest of the living monkey was opened and a cannula was inserted into the ascending aorta. Warm normal physiologic solution of sodium chloride was run into the aorta at a pressure corresponding to normal systolic blood pressure; the right auricle was immediately opened, and the blood was rapidly washed from the vascular system. After a very short time, during which the animal continued to breathe and the heart continued to beat, Kolmer's solution was run into the aorta and the entire vascular system perfused with the fixative. The eyes were then enucleated rapidly and placed in Zenker's solution for further fixation.

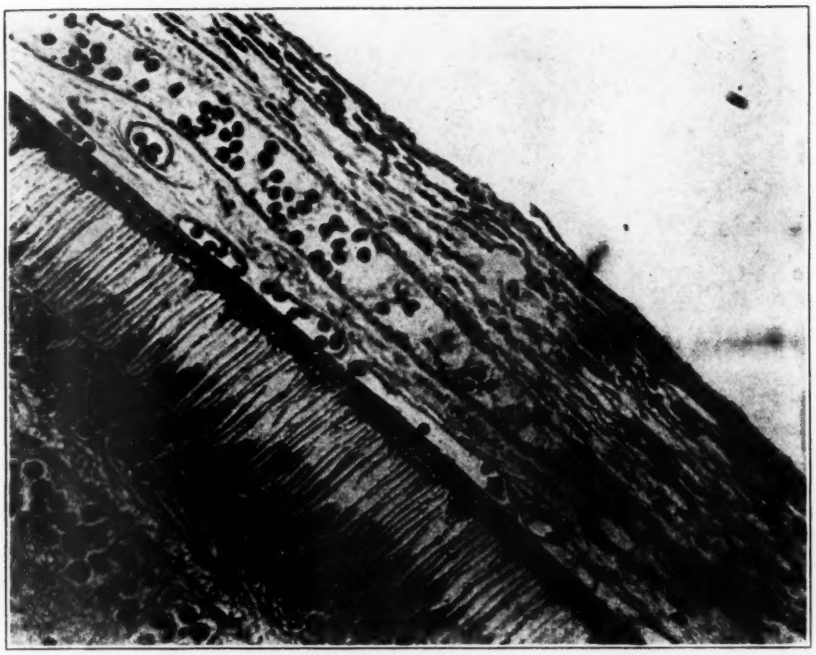

Fig. 1.—Large vein in anterior choroid of normal human eye.

Fig. 2.—Albuminous fluid in suprachoroidal space of normal human eye.

Fig. 3.—Albuminous fluid in suprachoroidal space of normal human eye.

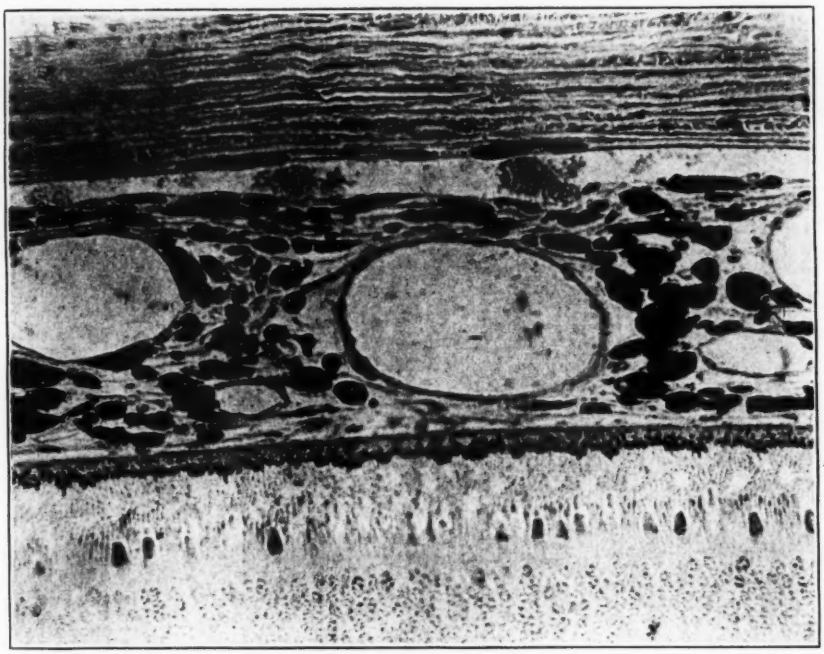

Fig. 4.—Albuminous fluid in suprachoroidal space of normal monkey eye fixed in vivo.

PATHOLOGY

In three human eyes with massive choroidal detachment a portion of the suprachoroidal fluid was withdrawn through a scleral puncture. The fluid was almost colorless and coagulated within a few minutes. Microscopic examination showed an albuminous fluid, fibrin and a few red blood cells. On chemical analysis the fluid was found to contain much protein and gave a positive test for bilirubin. It was therefore considered to be a transudate of the blood.

Histologic sections of one unopened normal monkey eye, fixed in vivo according to the technic described, showed small amounts of

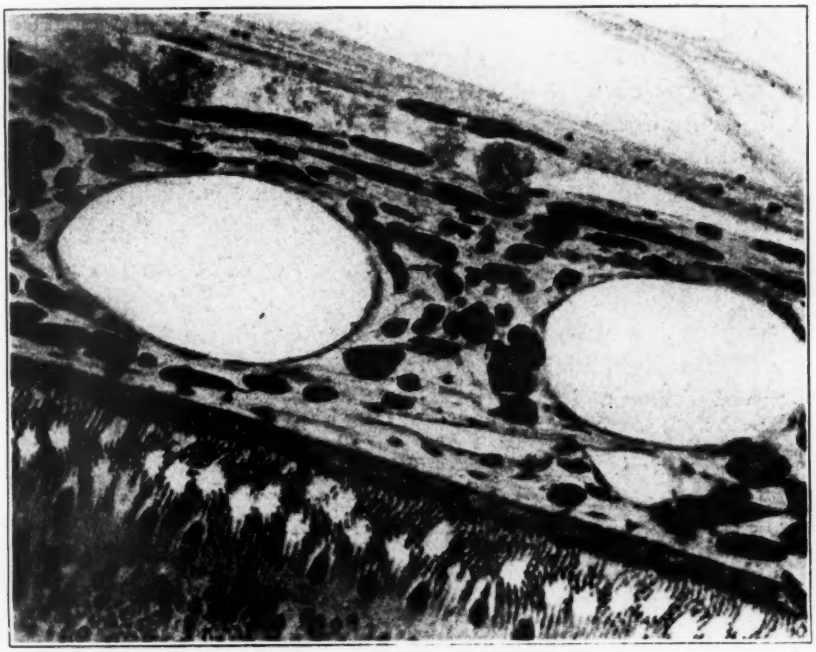

Fig. 5.—Albuminous fluid in suprachoroidal space of normal monkey eye fixed in vivo.

albuminous fluid in the suprachoroidal space (figs. 4 and 5). The blood had been washed from the intra-ocular vessels; consequently serum could not have entered the suprachoroidal space except during life and under normal conditions. Similar findings were observed in three normal human eyes removed on account of orbital tumors (figs. 2 and 3). These observations led to the belief that small amounts of fluid are normally present in the suprachoroidal space.

Three monkey eyes from which the lenses were extracted were fixed in vivo immediately after the operation; they showed larger amounts of suprachoroidal fluid than that found in the unopened

monkey eye (figs. 6 and 7), but there was an insufficient amount to cause gross detachment of the choroid. In one eye an occasional extravascular red blood cell was seen in the suprachoroidal space. It is to be noted that these eyes were fixed a few minutes after cataract extraction, and a large amount of fluid was not to be expected.

One human eye, in which the choroid had remained detached for a period of three weeks, was removed two years later on account of glaucoma. The fundus could not be seen at the time of enucleation; consequently it was not determined whether there were pigment changes such as are sometimes visible in the fundus after reattachment of the choroid. Exhaustive microscopic study failed to reveal changes in the pigmentary epithelium or choroid. Verhoeff [15] described such an eye and believed the streaks of pigment to be the result of hyperplasia of the pigmentary epithelium along the creases which were present in the choroid during detachment.

DETACHMENT AT OPERATION

Detachment of the choroid immediately following operation has not been reported, but if it is due to the outpouring of serum from vessels overfilled with blood as a result of sudden reduction in intra-ocular pressure, transudation should begin immediately following section of the globe. With this thought in mind, during the past few months a number of eyes were examined within a few minutes after delivery of the lens, and in almost every eye in which the fundus was visible early detachment was observed. Details of the fundus, especially in the periphery, are well visualized in only a moderate number of cases, even after intracapsular extraction, since they are often partially or entirely obscured by the effect of cocaine on the corneal epithelium, waviness or collapse of the cornea, folds in Descemet's membrane or air or blood in the anterior chamber.

The detachment was observed after uncomplicated intracapsular extraction in twenty-four cases and after extracapsular operation in the remaining case. This probably does not mean that it occurs more often in the former, but simply that there was opportunity to observe more intracapsular extractions and that the fundus was rarely visible immediately after an extracapsular operation. It is believed that the type of cataract operation probably has little or nothing to do with separation of the choroid. Evidently the fluid accumulates first under the ciliary body and anterior choroid, since the detachment almost always appeared in the periphery and extended slowly backward toward the posterior pole. It was observed most frequently in the inferior periph-

15. Verhoeff, F. H.: Nature and Origin of Pigmented Streaks Caused by Separation of the Choroid, Tr. Sect. Ophth., A. M. A., 1931, p. 82.

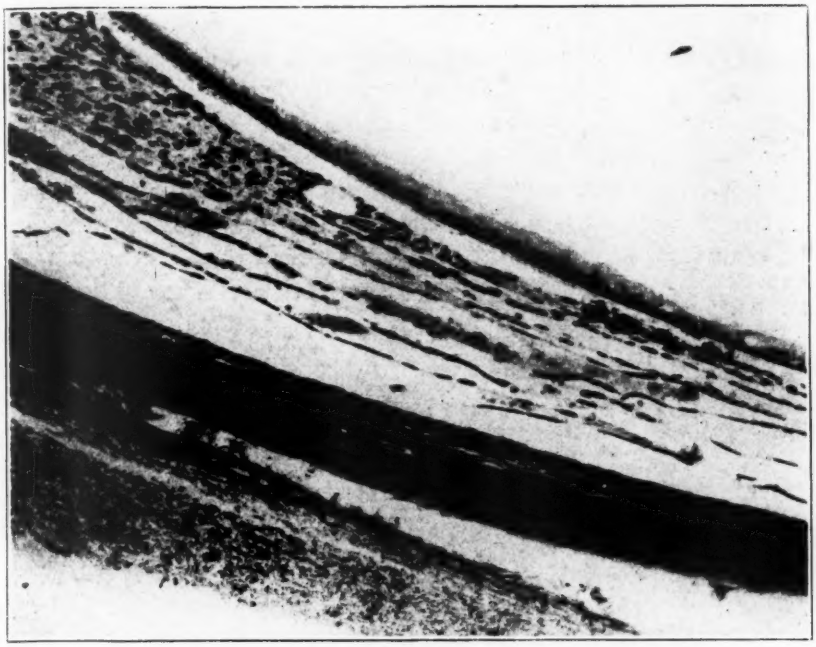

Fig. 6.—Albuminous fluid in suprachoroidal space of monkey eye fixed in vivo immediately after cataract extraction.

Fig. 7.—Albuminous fluid in suprachoroidal space of monkey eye fixed in vivo immediately after cataract extraction.

ery, either directly below or reaching somewhat nasally or temporally; it appeared at one or both sides in a few cases, but was not seen in the upper part of the fundus. This does not imply that it was not present all around in many cases; examination was somewhat difficult, and the entire periphery of the fundus was not always visible. The detachment at this stage was flat, and the border appeared as a curved, sharply demarcated, elevated, dark, shadowy line with its convexity toward the nerve head (fig. 8). The retinal vessels arched over this dark border and accentuated the appearances of elevation. The area of the fundus peripheral to and bordered by the dark curved line had a light translucent

Fig. 8.—Flat detachment of choroid immediately after operation.

appearance. On several occasions the dark bordering line was observed to move slowly toward the posterior pole as the detachment enlarged, but in only two cases did it reach within 3 or 4 disk diameters of the nerve head or macula. Such a flat detachment had none of the dark gray, globular appearance of the ordinary massive type which is commonly seen a few days after operation, but such an appearance is not to be expected, since the quantity of subchoroidal fluid is small at this time and the elevation is not great. Examinations the day following operation were much more difficult, since striate keratitis often interfered with the visibility; they revealed no detachment in those cases in which the anterior chamber was reformed, but in those with an empty chamber

the detachment sometimes had progressed, covered a larger area and assumed the typical dark globular appearance. As more of these cases are observed the belief grows that detachment probably always occurs.

Lens extractions were made on three monkeys in an effort to determine immediate changes in the appearance of the fundus, but intracapsular extraction was impossible, and following extracapsular extraction the fundus was not visible.

DETACHMENT AFTER OPERATION

Detachment was first noted in fifty cases at intervals from the first to the seventh postoperative day. It is to be noted that these eyes were not examined with the ophthalmoscope at the time of operation. In forty-one cases detachment followed intracapsular extraction, and in nine it occurred after extracapsular operation.

Detachment occurring within the first days after operation invariably followed delayed closure of the wound or early rupture of loosely adherent margins of the wound, while those which occurred later followed rupture of the wound. Often the opening in the wound was extremely small and invisible; however, its presence was recognized by signs of leakage of aqueous, e. g., folds in Descemet's membrane, a shallow or empty anterior chamber, softness of the eyeball and the presence of a green stain at some point along the margin of the wound after the instillation of fluorescein. The anterior chamber was not invariably shallow or empty, since with very slow leaks the chamber was occasionally of normal depth. However, the intra-ocular tension was low, and the eye was soft.

The detachment invariably appeared in the periphery of the fundus, either remaining confined to this area or slowly extending backward. In thirty-three cases it encircled the entire periphery, a finding contrary to the belief that it is usually located only at the sides. As a matter of fact, it was almost always more extensive medially and laterally, but in a few cases the greatest separation was below. In no case, no matter how extensive, did the detachment reach the region of the macula or nerve head. The extent of the separation was less in cases in which the wound remained open only a short time; it was more extensive in those in which there was leakage of aqueous over a period of days.

Detachment is to be expected in cases with a shallow or empty anterior chamber, folds in Descemet's membrane and a soft eyeball. If daily ophthalmoscopic examinations are not made the detachment may be discovered after the aforementioned signs have disappeared, but at the time of detachment these pathognomonic signs of aqueous leakage are present. In a typical detachment of moderate extent the detached choroid appeared as a dark orange-gray, globular elevation in the peripheral portions of the fundus (fig. 9). It was usually composed of several,

large, rounded, adjoining elevations separated by deep creases (figs. 10 and 11); the borders were dark and the surface was smooth, and not wavy or mobile as in retinal detachment. The retinal vessels were visible on the surface, but the color was unchanged, and they did not have the dark appearance of those in detachment of the retina. By oblique illumination and with the slit lamp large detachments appeared grayish brown mottled with dark brown. Transillumination showed exaggerated lighting of the sclera over the area of the detachment, a finding first described by Hagen.[8]

The detachment usually disappeared slowly, since the suprachoroidal fluid was not rapidly absorbed. Small flat detachments in the periphery

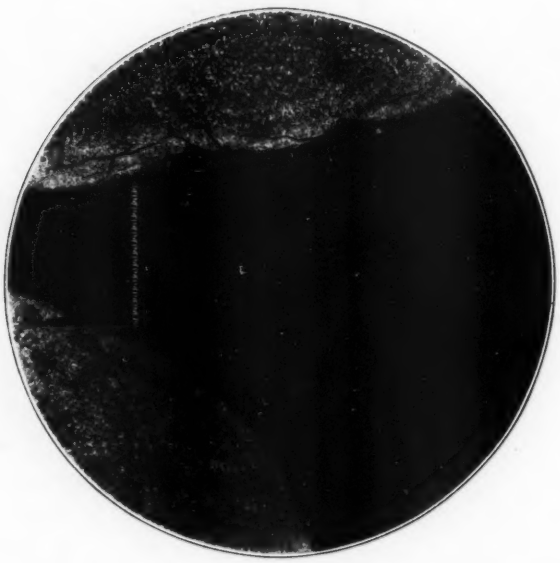

Fig. 9.—Detachment of choroid a few days after cataract extraction.

sometimes disappeared within a few hours, but those of moderate or great extent required several days after closure of the wound. In this series of cases the detachment was visible for a period of time varying from one to forty-two days. As the detachment became flatter and lessened in extent, it gradually assumed a lighter color.

After reattachment there were no visible changes in the fundus in those cases in which the separation was of short duration, but pigmentary disturbances were sometimes visible in those in which the detachment remained several weeks. In the area of former detachment the fundus appeared moth-eaten, and streaks, granules and clumps of pigment were seen.

Fig. 10.—Detachment of choroid a few days after cataract extraction.

Fig. 11.—Massive detachment of choroid a few days after cataract extraction.

DIFFERENTIAL DIAGNOSIS

Sarcoma of the choroid is easily differentiated, since the intra-ocular tension is normal or elevated and transillumination shows interference with the transmission of light in the affected area. Retinal detachment has an entirely different appearance: The retinal vessels are dark, and usually wavy folds are visible in the elevated retina.

PROGNOSIS

The prognosis is good. The choroid invariably resumed its normal position, and central visual acuity was apparently unaffected. The visual fields were studied in some cases a few weeks after reattachment and were found to be normal.

TREATMENT

An effort should be made to promote closure of the wound, but otherwise treatment is unnecessary.

CONCLUSIONS

Detachment of the choroid after cataract extraction occurs, so far as can be determined, almost invariably at the time of operation. It is due to the reduction of intra-ocular pressure, with subsequent congestion of the uveal vessels and a rapid and exaggerated transudation of fluid from the thin-walled veins of the ciliary body and anterior choroid into the normal perichoroidal lymph space. The detachment appears in the periphery of the fundus as a translucent elevation, bordered by a dark shadowy line with its convexity toward the nerve head.

Large detachments follow delayed closure or rupture of the wound. At the time of detachment there are folds in Descemet's membrane; the anterior chamber is shallow or empty, and the globe is soft. Examination of the peripheral portions of the fundus reveals one or more dark, orange-gray, tumor-like masses which may be localized but more often surround the entire periphery.

LIGHT STIMULI OF MINIMAL MEASURED DURATION AS A MEANS OF PERIMETRY

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In a previous communication [1] it was determined that for the average normal person there exists a zone between 50 and 60 degrees on the horizontal temporal meridian outside of which there is no perception for a rapid flash of light or a speed of approximately one twenty-five thousandth of a second. As was stated at that time, such determinations were found during the attempt to study a method for investigating the chronaxia of the optic nerve.

Perimetry has a long history dating from the time of Ptolemy; [2] its scientific basis was laid down by von Graefe [3] and Förster [4] and is further elaborated in the present-day texts of Peter [5] and Traquair.[6] Many are the contributions to perimetry, but as yet no one has made use of the flash of a light as a test target. Presentation of this new method was received with much interest two years ago at a meeting of neurosurgeons in Chicago, and a brief outline of the method and results was read before the Illinois Section of the Society for Experimental Biology and Medicine.[7]

The purpose of the present article is to make available to those interested brief summaries of certain cases in which this method of examination was used in the past two years. The majority of the patients were from the services of Dr. Loyal Davis and Dr. Lewis J. Pollock at Passavant Memorial Hospital and Michael Reese Hospital. Other reports were obtained from various sources.

From the Departments of Ophthalmology, Nervous and Mental Diseases and Experimental Surgery of the Northwestern University Medical School.

1. Mayer, L. L.: Visual Fields with Minimal Light Stimulus, Arch. Ophth. **9**:353 (March) 1933.

2. Ptolemy: Liber de speculis, translated into Latin from the Greek, 1518; quoted by Rose, V.: Anecdota Graeca et Graeco-latina, 1870, vol. 2, p. 317.

3. von Graefe, A.: Ueber die Untersuchung des Gesichtsfeldes bei amblyopsichen Affectionen, Arch. f. Ophth. **2**:258, 1856

4. Förster, in Wood, C. A.: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1918, vol. 12, p. 9432.

5. Peter, L. C.: Principles and Practice of Perimetry, ed. 2, Philadelphia, Lea & Febiger, 1923.

6. Traquair, H. M.: Introduction to Clinical Perimetry, St. Louis, C. V. Mosby Company, 1927.

7. Mayer, L. L.: Perimetry with Stimuli of Minimal Duration, Proc. Soc. Exper. Biol. & Med. **32**:219, 1934.

THE INSTRUMENT

The technical details of the special apparatus were evolved through the cooperation of Mr. H. J. Holmquest, Consulting Engineer of the General Electric X-Ray Corporation in Chicago. It consists of an appropriate electrical circuit whereby a neon discharge tube can be lighted for various periods ranging from 1×10^{-5} to 4×10^{-5} second. The neon tube is so arranged that the flash covers a circular area comparable to the ordinary 2 mm. test object. The lamp may be mounted on the Schweigger hand perimeter or on the instrument described by Ferree and Rand and may be moved at the discretion of the operator. The physical and electrical characteristics of this device will be described elsewhere.[8]

THE METHOD

The patient was seated in a comfortable chair near the Ferree and Rand perimeter,[9] and thus an illumination of 7 foot-candles was maintained for the background. An opaque patch was used to cover the eye not being examined. From ten to fifteen minutes were allowed in order to allow the eye to gain a degree of dark adaptation. The Schweigger hand perimeter [10] was held in close proximity to the eye. Fixation was readily accomplished by the reflected eye in the mirror at the center of the perimeter. The neon tube was moved along the arm of the perimeter, a flash occurring at intervals under control of the operator. The end-point was taken at the position just beyond the setting at which a flash was recognized by the subject, i. e., where the flash was no longer visible. The routine was to begin at the horizontal meridian on the temporal side and work down into the lower temporal quadrant and then back up, completing the entire circle. Temporary recording was made on the visual field slate which has been described elsewhere.[11] This temporary recording was later transferred to a permanent record. Scotomas within the circumference were determined and outlined by creating flashes in the indicated vicinity.

While this was the usual method, departures from it were necessary at times, just as in ordinary perimetry, in order to take care of various situations. When the patient was bedridden it was necessary to attempt to duplicate general illuminative conditions at the bedside. If the function of the retina was greatly decreased it was necessary to decrease general illumination, and in some instances complete darkness was needed before competent response could be recorded. The use of luminous paint on the arm of the perimeter and on the visual field slate permitted adequate recording of the results of such examinations. Since construction factors did not permit the test object to approach nearer the central fixation point than 5 degrees, central scotomas were outlined by removing the tube from the arm of the perimeter and simply holding it in the hand. This disadvantageous feature will be overcome in a new instrument which is now under construction.

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8. Holmquest, H. J., and Mayer, L. L.: Tr. Am. Ophth. Soc., to be published.

9. Ferree, C. E., and Rand, G.: The Campimeter, Tr. Am. Ophth. Soc. **18**: 164, 1920.

10. Schweigger, C.: Ein handliches Perimeter, Arch. f. Augenh. **19**:469, 1899.

11. Mayer, L. L.: A Visual Field Slate, Tr. Sect. Ophth., A. M. A. 1933, p. 295.

Photographs of the instrument as adapted to the hand perimeter are shown in figures 1 and 2.

RESULTS

In this study the speed of the neon flash was set at one twenty-five thousandth of a second. As a rule this was found to be the most prac-

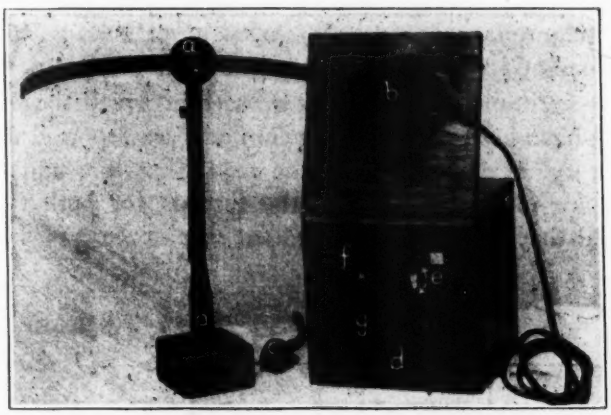

Fig. 1.—Set-up for flash perimetry: *a*, Schweigger hand perimeter; *b*, flash unit; *c*, socket for attachment to direct or alternating current; *d*, box housing condenser and transformer mechanisms; *e*, plugs for wire to neon tube; *f*, flash button; *g*, speed regulator.

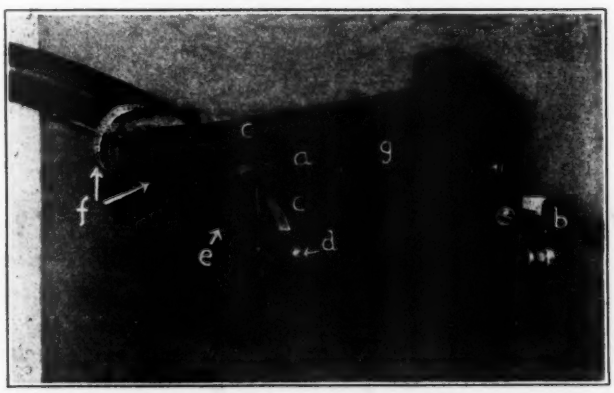

Fig. 2.—Close-up view of flash unit used as target: *a*, neon bulb for flashing; *b*, wire plugs from housing box; *c*, frame for bulb to ride on arm of perimeter; *d*, stop screw; *e*, opening for flash; *f*, ratchet for wedge (not included in this paper); *g*, lamp socket.

tical clinical setting. The limits of the visual fields were determined in the following twelve meridians: 0, 30, 60, 90, 120, 150, 180, 210, 240, 270, 300 and 330 degrees. Figure 3 shows the averaged results of three determinations on the right eye of twenty normal adults and the averaged fields for white and red when the 2 mm. test object was

used. The latter field was included in order to eliminate the possibility that the neon flash, which is red, might be simulating the ordinary red color field.

For the purpose of systematic study the findings may be divided into five groups: (1) normal fields of patients with signs suggestive of intracranial disease, (2) fields of patients with hysteria, (3) fields of patients with pituitary disease, (4) fields of patients with other intracranial lesions and (5) fields of patients with intra-ocular disease.

For this preliminary report a few cases in which the findings were outstanding have been chosen at random and are reported together with a brief history. Comparisons of the field for white and that for the neon flash are illustrated. When the records for both types of field were normal they have been omitted, to save space.

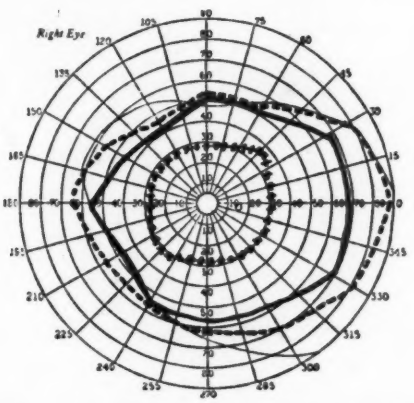

Fig. 3.—Visual fields. Averaged results of three determinations on twenty normal right eyes. The results of examination are indicated as follows: solid line, results with the neon flash; line of dashes, results with a 2 mm. red object; line of crosses, results with a 2 mm. red object.

REPORT OF CASES

CASE 1.—E. O. complained of sudden loss of vision; the condition had been present for one week. There was periodic numbness of the right arm and leg. The left pupil was larger than the right, but both pupils reacted normally. Visual acuity was: in the right eye, ability to count fingers at 1 foot (30 cm.); in the left eye, ability to recognize movements of the hand. The disks were flat. Roentgen examination showed a deep floor but no destruction of the clinoid processes and evidence of suprasellar tumor with increased intracranial tension, the tumor being located more to the left than to the right of the midline. Operation revealed no tumor. A diagnosis of arachnoiditis was made. The fields as measured by the flash method showed no evidence of a chiasmal syndrome. Subsequently a diagnosis of multiple sclerosis was made. The fields as measured by the ordinary method were also normal.

CASE 2.—E. A., aged 18, had suffered with severe frontal headaches for some months. The patient had grown much in the past six months. Physical examination gave negative results, and a psychiatric study was uninformative. Visual

acuity was 20/15 in each eye. Roentgen examination of the sella showed a suspicious shadow near the posterior clinoid processes. The fields as measured by the ordinary method showed partial bitemporal hemianopia; the fields as measured by the flash method were normal. The headaches became intolerable; slight relief followed spinal puncture. The spinal fluid was not under increased pressure, and at operation the chiasm was found to be entirely normal. Subsequently a diagnosis of hysteria due to social maladjustment was made. The fields as measured by the ordinary method were contracted to 60 degrees temporarily.

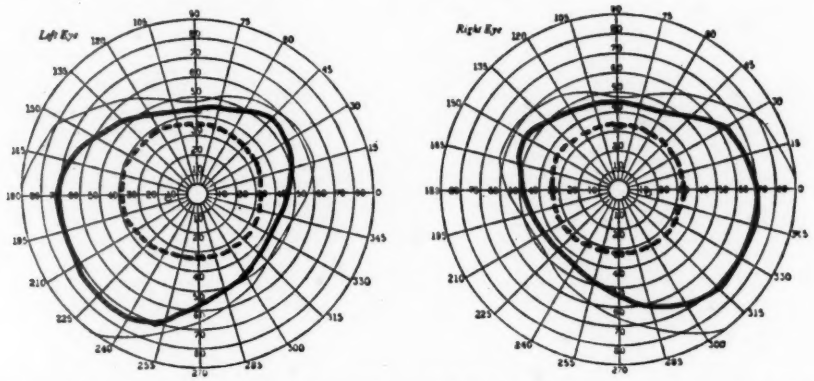

Fig. 4 (case 3).—Visual fields. The solid line indicates the result of examination with the neon flash; the line of dashes, the results of examination with a 2 mm. white object.

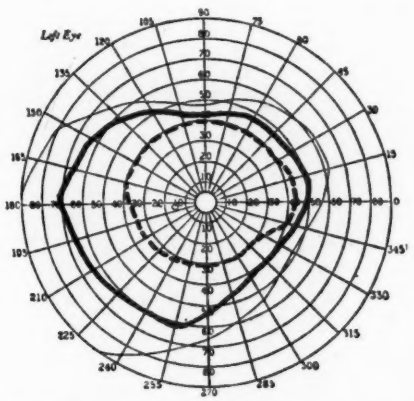

Fig. 5 (case 5).—Visual fields for the left eye. In this figure and in the succeeding ones, except figure 7, the solid line indicates the results of examination with the neon flash, and the line of dashes, the results of examination with a 2 mm. white object. (The right eye was amblyopic; fields were obtainable neither with the flash nor with ordinary test objects.)

CASE 3.—J. P., aged 11, gained much weight shortly before being seen and weighed 112 pounds (50.8 Kg.). There were no complaints. The patient's father, a physician, suspected the presence of a pituitary growth, but physical and roentgen examinations gave negative results. The fundi and the visual acuity were normal. The fields as measured by the ordinary method were tubular at 16.5 cm., at 33 cm.

and at 2 meters. The fields as measured by the flash method were normal. Subsequent observation continued for two years showed no change.

CASE 4.—A. R., aged 10, had epilepsy which began at the age of 3 years. Recently attacks had become more severe and more frequent. The right arm and

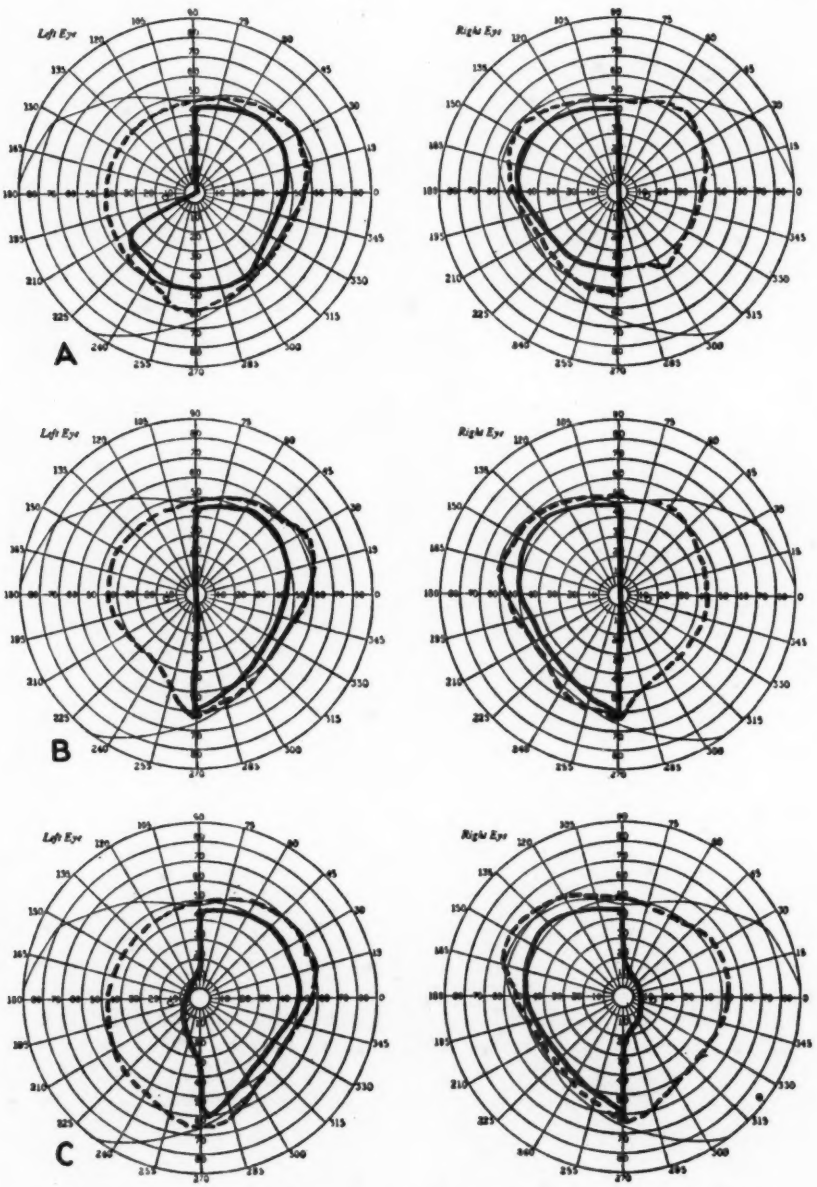

Fig. 6 (case 6).—*A*, visual fields on Jan. 2, 1933; *B*, on Feb. 2, 1933; *C*, on Feb. 23, 1933 (after operation).

leg were affected during seizures. The physical examination gave negative results. Ophthalmic examination showed that visual acuity and the fundi were normal. The results of ordinary perimetric examination masked any attempt at localization,

the fields being tubular; the fields as measured by the flash method were normal. The fields as measured by the ordinary method were comparable to those of J. P. (case 3).

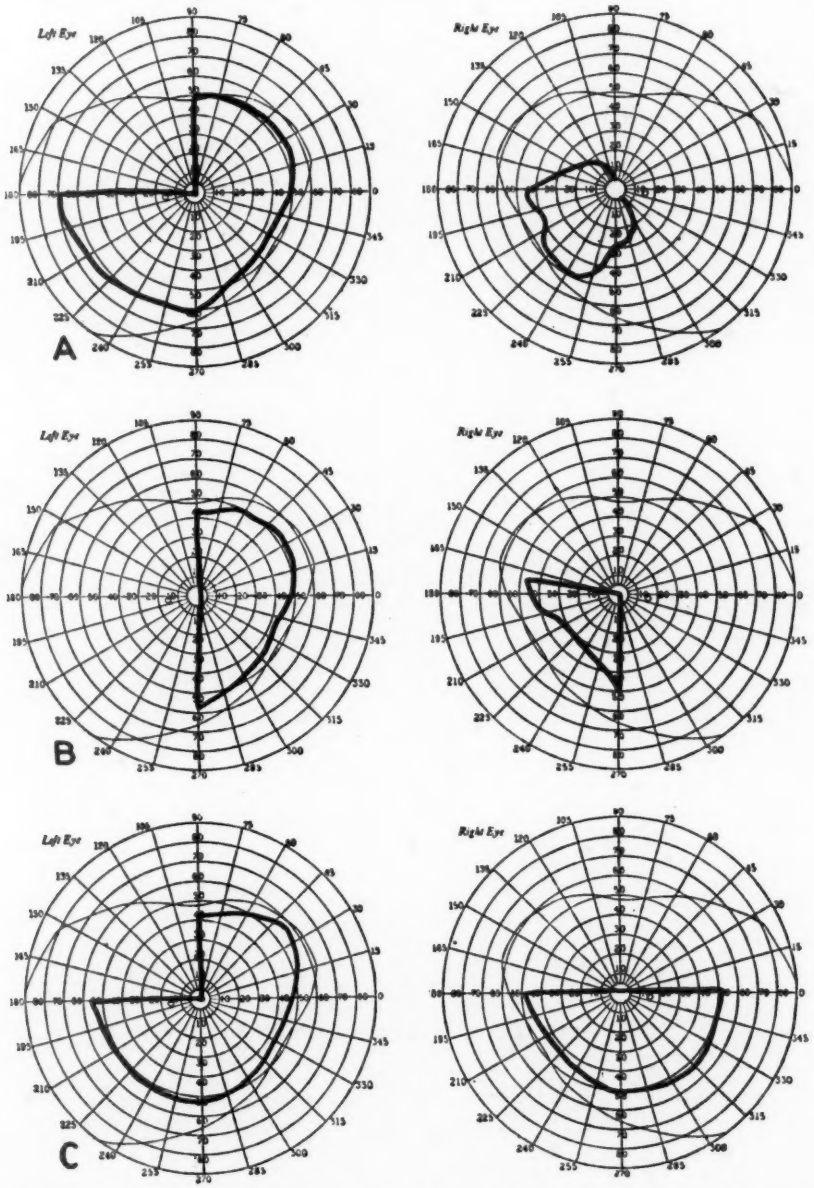

Fig. 7 (case 7).—*A*, visual fields on Sept. 12, 1932. Vision was 20/40 in the left and 20/20 in the right eye. *B*, visual fields on April 14, 1933. Vision was 20/100 in the left and 10/200 in the right eye. At operation evidence of a hemorrhage in the capsule was found. *C*, visual fields on May 5, 1933, after evacuation of the hemorrhage. Vision was 20/40 in the left and 20/20 in the right eye.

Case 5.—B. C., aged 45, complained of sudden loss of vision. The patient was able to distinguish shadows only but walked around unaided. Physical, laboratory and roentgen examinations gave negative results. The pupils were normal. Visual acuity was 0 in the right eye; in the left it was restricted to perception of motion of the hand. For many years the patient had worn lenses for correction of high hyperopia. The fields for the right eye were unobtainable by the ordinary and by the flash method. The fundi were normal. There were no central scotomas. The field as measured by the ordinary method was tubular for the left eye; the

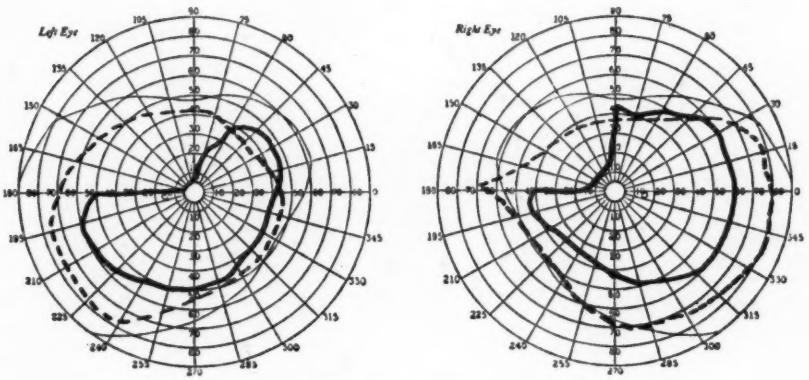

Fig. 8 (case 9).—Visual fields.

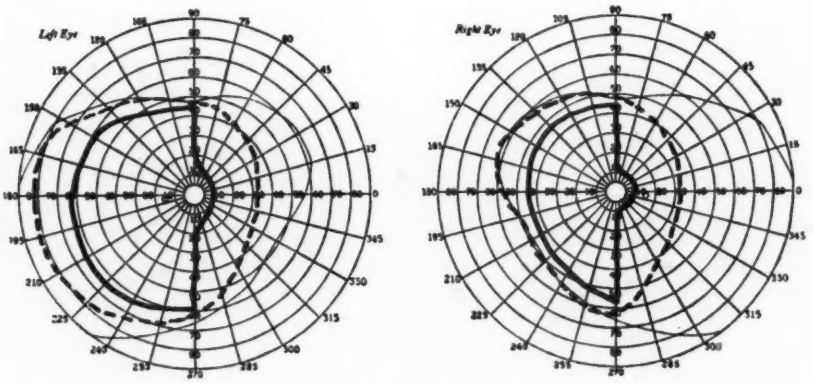

Fig. 9 (case 10).—Visual fields on Jan. 10, 1933.

field as measured by the flash method was normal. Subsequent examination revealed that the right eye had always been amblyopic. The diagnosis was hysteria.

Case 6.—R. B. W., aged 29, had shown signs of pituitary tumor, headaches, polydipsia and polyuria for six months. The patient was willing to undergo an operation but wanted to delay it because of business. The disease progressed, and the fields as measured by the ordinary and flash methods showed marked increase in contraction, the contraction being especially marked in the fields as measured by the flash method. The operation could not be postponed longer.

Case 7.—M. S., aged 33, complained of loss of vision and disturbances of locomotion and of frequent and severe headaches. The headaches, polydipsia,

polyuria and changes in the fields all indicated the presence of a pituitary tumor. Figure *7 A* shows the fields before operation. After the operation there was improvement for six months; then the symptoms returned, and the visual fields showed the defects depicted in figure *7 B*. The wound was reopened, and a large hemorrhagic area was found in the sac. Figure *7 C* shows the fields after the second operation.

CASE 8.—C. B., aged 51, complained only of cerumen in the ear but presented all the signs of acromegaly. The fields as measured by the ordinary method were

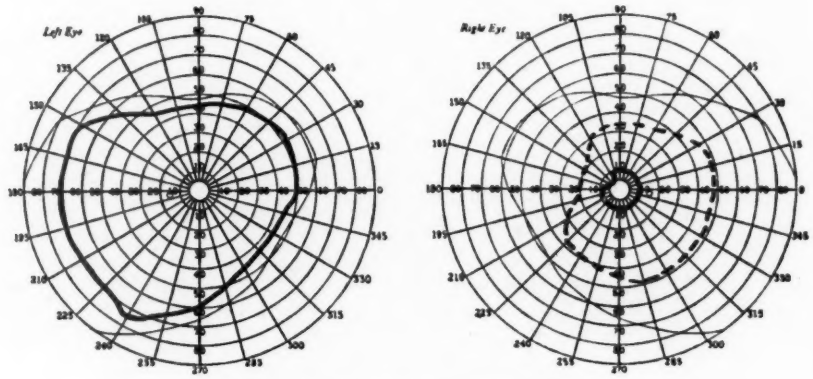

Fig. 10 (case 12).—Visual fields.

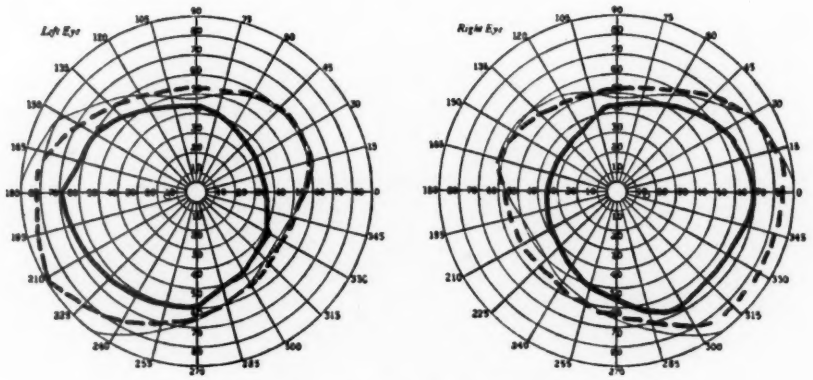

Fig. 11 (case 13).—Visual fields.

tubular, and there was no way of determining whether the pituitary gland impinged on the chiasm. The fields as measured by the flash method were normal and showed no involvement. The fields were comparable to those of J. P. (case 3).

CASE 9.—C. L., aged 43, complained of dizziness, severe headache and drowsiness. Both disks were choked. The patient was uncooperative. Figure 8 shows a comparison of the fields as measured by the ordinary and by the flash method. A tumor of the right temporal lobe was found at operation.

CASE 10.—M. V., aged 38, complained of loss of vision, dizziness and weakness of the right side. Both fields showed defects of a localizing nature. The abrupt limitation of the fields as measured by the flash method was noteworthy. A tumor of the left parieto-occipital lobe was removed at operation.

CASE 11.—E. U. suffered from traumatic epilepsy due to an injury sustained at birth. At operation a scar in the dura was removed. Examination of the fields one month after the operation showed no change in the fields as measured by the flash method. The results of the first ordinary perimeteric examination augured well for recovery of the fields; however, normal fields were not regained after two years. The fields were comparable to those of M. S. (case 7).

CASE 12.—M. D., a patient of Dr. James Lebensohn, had glaucoma of the right eye. After comparison of the fields it was decided that operation was indicated. The result was excellent.

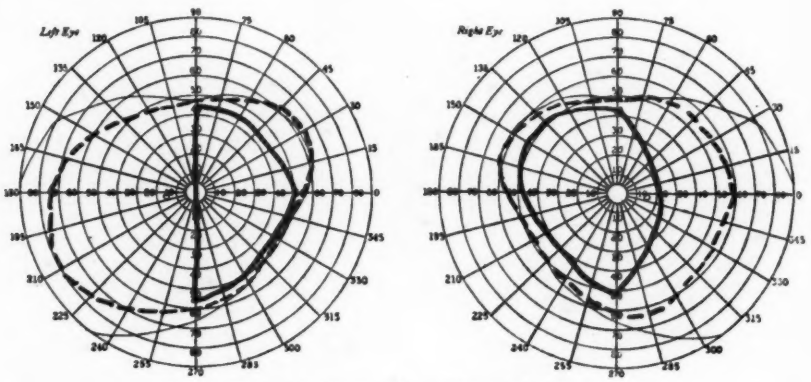

Fig. 12 (case 14).—Visual fields.

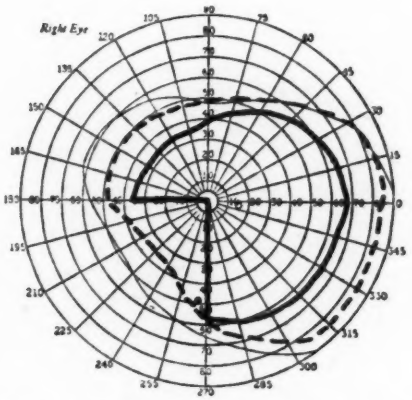

Fig. 13 (case 15).—Right visual fields.

CASE 13.—M. W., aged 41, was seen five years ago with subacute bilateral chorioretinitis. The etiologic factor was not found. At that time the fields and tension were normal. Three years later tension in the right eye was 25; in the left it was 23. Through administration of miotics this condition was controlled for a time; later the defects in the fields as measured by the flash method caused the tension to be taken; it was found to be 32 in the right and 25 in the left eye. Operation was indicated.

CASE 14.—J. A. presented Argyll Robertson pupils. The Wassermann reaction of the blood was negative; that of the spinal fluid was positive. Figure 12 shows

the fields at the first visit. There were no neurologic signs of pituitary involvement. The case was regarded as one of syphilis affecting the chiasm.

CASE 15.—Mrs. H. J. R., a patient of Dr. Sanford R. Gifford, had traumatic detachment of the retina. The fields were taken after operation. The prognosis was made cautiously because the fields as measured by the flash method did not show the extent of recovery of the fields as measured by the ordinary method. A second operation was necessary to bring about complete recovery.

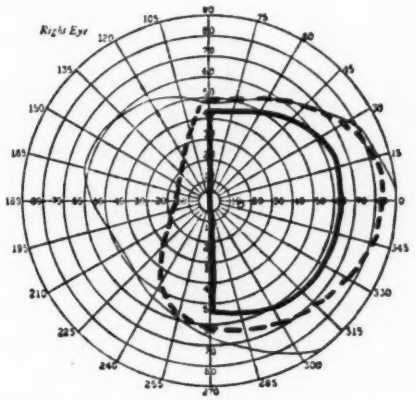

Fig. 14 (case 16).—Right visual fields.

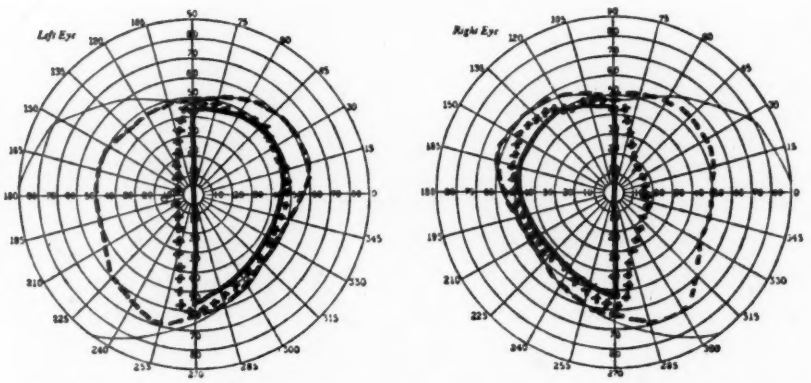

Fig. 15 (case 17).—Visual fields. The solid line indicates the results of examination with a neon flash at 165 mm.; the line of dashes, the results of examination with a 2 mm. white object at 165 mm., and the line of crosses, results of examination with a 6 mm. object at 2,000 mm.

CASE 16.—Dr. E. H. W. suffered from detachment of the retina following extraction of a cataract. An operation by electrocoagulation was performed. Figure 14 shows a comparison of the fields after operation. No subsequent comparable examinations were made. The end-result was not known.

CASE 17.—E. N. showed symptoms and signs of a pituitary lesion. A comparison of the fields as measured by the ordinary method, by the flash method and by the Bjerrum method as taken by Dr. Sanford R. Gifford is shown in figure 15.

COMMENT

A critical survey of this report makes it evident that the new method for delineating the visual fields leaves much to be desired. Modifications of the instrument and of the technic of its application have been made during the period in which it has been used, and others will be made in the future. To summarize the value of the findings in each individual case or in each group is not feasible at the present time. However, certain outstanding developments would bear reiteration. A large group of patients have shown tubular fields, which were attributed to a concentric contraction denoting hysteria. This frequent result of the usual perimetric examination has no counterpart when the flash target is used. With the flash method in no case was there found a tubular field as indicative of hysteria.

That the progress of a lesion and the signs of recovery are more critically analyzed by the flash method has been frequently shown in cases of pituitary disease, glaucoma and detachment of the retina. Certain unexplainable or new findings elicited by the flash method are difficult to interpret. The explanation must remain in abeyance until such time as operation, autopsy or the repeated finding of such results is able to replace guess work. In order to emphasize another salient point, case 13 has been included. Naturally, the question as to how the field as obtained by the flash method compares with the results of a carefully made quantitative investigation by means of the tangent screen is to be expected. The answer seems to be that with the flash method the results are the same. However, it is definitely decided as far as I am concerned that the flash method is simpler and easier and requires less time and effort for a real critical analysis. Elimination of the movable target adds much value to the flash method. This has been admirably expressed by Ferree and Rand.[12]

> The following errors attending the use of moving stimuli in the study of the field of vision may be noted: (*a*) A much poorer control of fixation is had however good a fixation device is used. That is, there is a tendency for the eye to follow the moving stimulus, the act of fixation is prolonged unduly, and the eye of the patient is not under the observation of the examiner at the time the judgment is made. (*b*) The variable effects of previous exposures of the eye on the sensitivity of the retina at the point of examination cannot be so effectively eliminated. (*c*) There is a time error which cannot be standardized. The report is given after the stimulus has passed the critical point, the amount of error depending on both the rate of movement of the stimulus and the slowness of the reaction of the patient. The reactions of many pathologic observers, it may be noted, are very slow.

12. Ferree, C. E., and Rand, G.: A Central Vision Scotometer, Arch. Ophth. **9**:608 (April) 1933.

The use by other operators of this new device will undoubtedly lead to modifications of the instrument, changes in technical methods and variations in interpretations. It is hoped that soon instruments of this type will be available so that others may enjoy the advantage of perimetry with such slight expenditure of energy.

IMPRESSIONS AND CONCLUSIONS

With the introduction of a new, practical instrument the value of a rapid light flash used as a target in perimetry has become estimable.

The stationary nature of the target eliminates the factor of movement, and thus a variable of great importance need not be considered.

The technic used in the examination is simple. Neither observer nor patient need be fatigued by the procedure.

The flash is definite. It is recognized or it is not seen.

Bedridden patients are easily examined.

Defects in the fields are exaggerated to a degree formerly detectable only by a far more painstaking method which also calls for greater cooperation and intelligence on the part of the patient.

A fundamental and fairly complete interpretation of all the findings delineated by this method must await further study of cases and subsequent confirmation by biopsy and autopsy.

NOTE.—Reference is also made to an article by Phillips [13] which appeared during the time this paper was in preparation in which the use of the phenomenon of flicker to outline the visual fields is reported.

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13. Phillips, G.: Perception of Fields in Lesions of the Visual Pathways, Brain **56**:464, 1933.

USE OF COLEY'S MIXED TOXINS IN OPHTHALMOLOGY

FURTHER OBSERVATIONS

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In a previous issue of the ARCHIVES [1] appeared my first report on the advantages of Coley's mixed toxins as a foreign protein in ophthalmologic therapy. In that article a résumé of the history of foreign protein therapy was given, and the various proteins used in ophthalmologic practice were discussed.

What is the preparation known as Coley's mixed toxins? It is a vaccine made from killed cultures of Streptococcus erysipelatis and Bacillus prodigiosus. It is in extremely concentrated form, a red-colored fluid put up in rubber-capped glass vials of 1 cc. and 15 cc. capacity by Parke-Davis and Company. It keeps well in an icebox, and the expiration date printed on each vial can be ignored, as the fluid does not lose its efficiency over a period of several years.

How is it administered? These mixed toxins are given intramuscularly, and the deltoid muscle is used because the dose is only 3 minims (0.18 cc.). A tuberculin syringe is employed with an ordinary hypodermic needle, which is plunged directly into the depths of the muscle.

What is the reaction? Invariably the reaction occurs about six hours after the injection. In several hundred cases in which the vaccine has been used the same observation has been noted repeatedly. The reaction consists of a chill and a fever, the latter varying between 101 and 103 F. and lasting from three to four hours. The chill is not constant but, when present, lasts for from one-half to one hour. Sometimes the site of the injection becomes red, swollen and painful. For this a large, cold wet dressing is used. I advise the patient to apply a large towel soaked in cold water if the pain is annoying.

Is the dosage constant? In robust adults 3 minims (0.18 cc.) can be given with impunity; in children or in elderly, weakened patients 1 minim (0.06 cc.) is used to start with. If the rise in temperature is absent or slight the dose is increased to 2 minims (0.12 cc.) and increased even beyond 3 minims if necessary. There are occasional cases in which a dose of 3 minims is not sufficient to cause an appre-

1. Levine, Joseph: Nonspecific Protein Therapy: Advangtages of Coley's Mixed Toxins, Arch. Ophth. **6**:75 (July) 1931.

ciable rise in temperature, and in these the dosage can be increased by 1 minim until a suitable reaction occurs. If, however, 6 minims (0.24 cc.) does not give any fever, some other form of foreign protein therapy should be resorted to, such as typhoid vaccine given intravenously or milk intramuscularly. In the several hundred patients treated by me and by other physicians at the Manhattan Eye, Ear and Throat Hospital and the Mount Sinai Hospital and in our offices it has been unusual not to get a good febrile reaction with 3 minims and extremely unusual to get no reaction with a dose as high as 6 minims.

How often is it given? An injection may be given every third day and may be repeated as often as necessary, depending on the response of the ocular inflammation to the fever. The criteria that are used with any other form of foreign protein therapy apply equally in the use of Coley's mixed toxins. If the ocular condition improves after the injection and the subsequent rise in temperature, and if further improvement is desired, another injection is given. If the inflammatory process subsides sufficiently after an injection so that in the physician's opinion further progress will continue without further protein therapy, no more injections are given. The same judgment is used as with any other form of foreign protein therapy.

In what condition is it used? It is of great help in any ocular inflammation in which any other form of foreign protein therapy would be helpful. Acute iritis, keratitis, kerato-iritis, cyclitis, irido-cyclitis, uveitis, secondary glaucoma due to any one of the preceding conditions and sympathetic ophthalmia are the conditions in which to use foreign protein therapy. The results are often astounding, as all who have used it can attest.

What are the advantages of Coley's mixed toxins?

1. The fluid is always ready for use in a rubber-capped glass vial. There is no boiling of the fluid to be done, as is necessary with milk. The fluid is already aseptic.

2. It is extremely easy to administer, being injected into the upper part of the arm deeply intramuscularly. It is not given intravenously as typhoid vaccine is given, nor is the gluteal region used as with milk, which is given in 10 cc. doses.

3. It is given in very small, easily measured amounts. Only 3 minims are used as a rule, sometimes less, very rarely as much as 6 minims. With the tuberculin syringe 3 minims is easily drawn up and seen because the fluid is red. With typhoid vaccine, complicated calculations are necessary to get the correct dosage in millions of bacteria.

4. The reaction to Coley's mixed toxins does not come on for six hours. This gives the patient plenty of time to get home, and there is no fear of a reaction setting in before that time.

5. The severity of the reaction may be controlled by varying the dose from 1 minim up to 6 minims. All degrees of reaction and of temperature are thus easily obtained.

6. It is extremely cheap. The usual dose of 3 minims costs less than 5 cents, and the fluid keeps indefinitely in a cool place.

7. No complications have occurred in several hundred injections at the office and at clinics. There has been no infection, no prostration, no unusually severe rise in temperature.

As with any other form of foreign protein therapy, no salicylates should be administered during the time that injections are given. It has been noted that the rise in temperature is often absent if salicylates are taken at the same time. I feel that a rise in temperature is essential to produce beneficial results when foreign protein therapy is employed. The use of aolan and other foreign proteins which do not cause a rise in temperature seems to me to be wasteful and useless.

The usual precautions in diabetic, arteriosclerotic, tuberculous, nephritic and cachectic patients are to be observed. It is to be remembered that no claims are made for Coley's mixed toxins other than those for any other efficient foreign protein. Of course, the temperature will not go so high as it does when artificially produced by the newer mechanical devices. However, the latter require hospitalization and the constant attendance of a physician and a trained technician.

CLOSURE OF THE ANGLE OF THE ANTERIOR CHAMBER IN GLAUCOMA

ITS BEARING ON OPERATIONS FOR THE RELIEF OF HYPERTENSION

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One of the most difficult endeavors in medicine is to eradicate beliefs and doctrines which, although based on insufficient or poorly supported evidence, have acquired, so to speak, a right of citizenship in science. Such has been the case with peripheral synechia and its rôle in the development of glaucoma. When Knies in 1876 and Weber in 1877 discovered the adhesion of the root of the iris to the corneoscleral limbus in sections of eyes enucleated after long-standing glaucoma, it was assumed that this was the primary cause, the origin, of all the symptoms which are characteristic of hypertension and glaucoma. According to this theory, the shutting off of the trabecula and Schlemm's canal by the iris adhesion entirely blocked the only outlet for the aqueous and produced a retention of fluids which gave rise to glaucoma.

It was not of much avail that study of eyes enucleated post mortem immediately after attacks of glaucoma in patients dying of intercurrent diseases had shown that the angle was entirely or partially open. As the greatest number of eyes examined by the pathologist showed an adhesion of the iris, it was assumed that this was always present, and it came to be considered as the outstanding diagnostic symptom of glaucoma.

When the gonioscope was devised and the angle of the anterior chamber could be observed in living eyes and at different stages of the disease, it was found that the condition of the structures was vastly different from that seen with the microscope. Salzmann,[1] who was the first to examine the angle in glaucomatous patients with the ophthalmoscope, found that in four cases of secondary traumatic glaucoma the angle was entirely free. In two of these cases there was a subluxation of the lens and in one a traumatic cataract. In three cases of chronic congestive glaucoma and in one of simple glaucoma the angle was partially closed.

From the Institute of Ophthalmology of the Columbia-Presbyterian Medical Center.

1. Salzmann, M.: Ophthalmoskopie der Kammerbucht, Ztschr. f. Augenh. **31**:1, 1914; **34**:26, 1915.

In my first paper,[2a] I reported on fourteen glaucomatous eyes examined with the gonioscope at different stages of the disease. Four of the eyes showed acute and chronic congestive glaucoma, and in two of these there was partial and in the other two total peripheral synechia. Six eyes had congestive attacks in the course of simple glaucoma; three of them had partial and three total synechia. Finally four eyes had simple glaucoma, each with an open angle.

In my second paper [2b] I reported on ten eyes: One eye presented an acute attack with partial synechia, and the partner had prodromic glaucoma with an open angle. Two eyes had chronic congestive glaucoma with a closed angle, and six eyes showed simple glaucoma, five with a partially closed angle (old cases) and one with an open angle.

In my third paper,[2c] read at the Fourteenth International Congress of Ophthalmology at Madrid in 1933, I reported on sixty-three glaucomatous eyes of forty-one patients. These eyes were selected from a great number of such eyes. The majority had been observed for long periods of time. Of these eyes twenty showed congestive glaucoma; twenty-four had the chronic simple type and thirteen secondary glaucoma. A résumé of the conclusions from the three series follows.

I. RÉSUMÉ OF AUTHOR'S PREVIOUS CONCLUSIONS ON SUBJECT

ACUTE AND CHRONIC CONGESTIVE GLAUCOMA

I observed twenty-six eyes with acute and subacute glaucoma, some of them immediately after or just before the attack. In seven eyes (26 per cent) I found the angle entirely open; in twelve (46 per cent) partly closed, and in seven (26 per cent) entirely closed. In cases of chronic congestive glaucoma eight eyes showed (table): the angle open in two cases (25 per cent); partly closed in two (25 per cent), and entirely closed in four (50 per cent). I think that in the beginning of the acute attack, if it is not severe and is of short duration, the angle is always open. If the attack persists or if relapses take place, the angle may close in part. Finally, when the attack is severe and lasts for a long time, the angle is usually closed all around the limbus. This proves that the closure of the angle is not the initial cause, but the result of the still unknown factors that produce primary glaucoma.

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2. (*a*) Troncoso, M. Uribe: Gonioscopy and Its Clinical Applications, Am. J. Ophth. **8**:433, 1925; (*b*) Gonioscopy in Glaucoma, in Contributions to Ophthalmic Science, dedicated to Dr. Edward Jackson in honor of his seventieth birthday, by his pupils and colleagues in the United States, Menasha, Wis., George Banta Publishing Company, 1926, p. 74; (*c*) Gonioscopy: Its Methods and Results, Especially in Glaucoma, Tr. Internat. Cong. Opth., Madrid, 1933, vol. 1, p. 25; (*d*) Pathogenie du glaucome. Recherches cliniques et expérimentales, Ann. d'ocul., December 1901, p. 126; An. de oftal. **4**:97, 135 and 167, 1901. (*e*) Troncoso, M. Uribe, and Reese, A. B.: Gonioscopic Findings After Elliot Operation, Tr. Ophth. Soc. U. Kingdom **53**:366, 1933; Am. J. Ophth. **18**:103 (Feb.) 1935.

Gonioscopy has shown that peripheral synechia is often partial, i. e., limited to a part of the angle. This is probably due to an edema of the ciliary body and turgescence of the processes limited to a particular vascular territory of the corona ciliaris, or to an agglutination of part of the corona to the cornea when the whole row of processes recedes after an acute attack. However, as gonioscopy has shown that during the course of the disease a new part of the angle may become closed without any previous acute attack, the former view is the more probable. These gonioscopic findings discrediting the idea that peripheral synechia is the first stage of primary glaucoma and the cause of the retention of fluids in the eye bring to the fore the physicochemical theories which ascribe the hypertension to changes in the chemical composition of the aqueous and vitreous and disturbances in the osmotic pressure through the inner wall of Schlemm's canal and the veins of the iris. I have constantly advocated, since 1901,[2d] that an increase in the proteins contained in the intra-ocular fluids, and not only an increase in the quantity of these fluids, is the primary agent in the development of hypertension and glaucoma. Duke-Elder, Friedenwald and others have proved experimentally that an increased amount of proteins in the aqueous gives rise to marked hypertension. Since 1901 I [2d] have also emphasized the importance of the vitreous swelling in the congestive type of the disease. Many authors believe that the increase in the volume of the vitreous is due to the physical nature of the vitreous gel, which has hydrophilic, turgescible properties and retains water in its colloidal substance. Lately, however, Cohen, Newell and Killian,[3] experimenting with ox vitreous, came to the conclusion that a true swelling of the vitreous gel is physically impossible, as only a small amount of the colloidal residue left by pressure ultrafiltration (0.1 per cent) is the part that swells. Thus, the intra-ocular pressure being due only to fluid pressure (i. e., a combination of the hydrostatic and osmotic forces), it is probable that the edema of the vitreous in glaucoma is the result of an increase of the proteins in the ocular fluids and fluid retention.

The importance of the vascular changes has been lately brought to the fore with the new conception of the increased permeability of the capillaries, especially in the choroid, as a source of increase of the fluids and colloids in the eye.

The rôle of the nervous system in the pathogenesis of congestive glaucoma is very considerable. It should be emphasized that the acute attack is a nervous vascular irritative crisis, which has especial significance in the eye because it is a closed organ in which an increased

3. Cohen, M.; Newell, and Killian: Experimental Studies on Swelling of the Vitreous Gel and on Intra-Ocular Pressure, Tr. Internat. Cong. Ophth., Madrid, 1933, vol. 1, p. 125.

amount of fluids and colloids gives rise to a retention that compresses and greatly endangers all its delicate structures. In other organs a vascular crisis which increases the in-put of fluids can be dissipated faster than in the eye, because in the latter the outlets are small and calculated to keep in the organ a certain amount of intra-ocular pressure.

Clinical Applications.—Gonioscopy in congestive glaucoma is of value in determining how far advanced the disease is. A partially closed angle offers a better prognosis than one totally occluded. The effects of physostigmine in detaching a recent synechia and the effects of operations such as iridectomy, trephining, cyclodialysis, iridotasis, etc., are easily determined by this method.

SIMPLE GLAUCOMA

In contrast with the congestive type of glaucoma, in the simple type the angle is almost always open. Of thirty-four eyes, the angle was open in nineteen (55.8 per cent), partly closed in thirteen (38.2 per cent) and closed in two (5.8 per cent). For years, while the congestive symptoms do not appear, the angle usually stays open, although the field of vision shows contraction and scotomas. When congestive symptoms appear, the angle starts to close. In six eyes of the first series, three (50 per cent) were found with the angle partly closed and three (50 per cent) with the angle entirely closed.

Very little is known about the nature and origin of simple glaucoma, but as a working hypothesis one may assume that it is a chronic vascular disease, not complicated by nervous disturbances and vascular crises. There are probably at first disturbances of nutrition in the retina and optic nerve, which lead to excavation of the disk. Only when a permanently increased capillary permeability appears and takes the leading rôle, and when nervous and congestive symptoms complicate the disease, does the tension become permanently high, with collection of colloidal fluids in the eye and the development of all the sequelae of the congestive form, including closure of the angle.

Clinical Applications.—When the angle is fully open and congestive symptoms do not exist, the ophthalmologist is justified in waiting and using miotics. On the other hand, if the visual field contracts and the Bjerrum scotoma enlarges steadily, if congestive symptoms appear and recur, and if the angle starts to close, the time has come for surgical intervention.

SECONDARY GLAUCOMA

The total number of cases of secondary glaucoma observed in this series was eleven, with thirteen eyes affected. As in simple glaucoma, the angle was fully open in the majority of the eyes (eight, or 61 per cent), partially closed in two eyes (15 per cent) and entirely closed in three eyes (23 per cent). The original diseases were: tuberculous

uveitis, two eyes; syphilitic iridocyclitis, one eye; simple glaucoma and syphilis, 3 eyes; diabetes, three eyes; traumatic glaucoma, two eyes (one after detachment of the retina), and thrombosis of the central vein, one eye. Hypertension did not close the angle in these cases from the beginning. In the case of tuberculous uveitis (case 32 [4]) it was only after seven months of increased tension that the angle started to close. In the case of thrombosis of the central vein after an acute attack the angle was still open on three sides. In the case of traumatic glaucoma after four years of flat detachment of the retina, deep excavation and a tension of 40 mm. the angle was still open (table).

Condition of the Angle of the Anterior Chamber in Glaucoma as Disclosed by Gonioscopy

	First Series	Second Series	Third Series	Total
Total number of eyes in each series	14	10	63	87
Congestive Glaucoma				
(a) Acute and chronic congestive glaucoma with acute or subacute exacerbations				
Number of eyes examined	4	2	20	26
Number with angle open all around	2	1	4	7 (26%)
Number with angle partly closed	2	1	9	12 (46%)
Number with angle closed	..	..	7	7 (26%)
(b) Chronic congestive glaucoma				
Number of eyes examined	..	2	6	8
Number with angle open	..	..	2	2 (25%)
Number with angle partly closed	..	..	2	2 (25%)
Number with angle closed	..	2	2	4 (50%)
Simple Glaucoma				
Number of eyes examined	4	6	24	34
Number with angle open	4	1	14	19 (55.8%)
Number with angle partly closed	..	5	8	13 (38.2%)
Number with angle closed	..	..	2	2 (5.8%)
Simple Glaucoma with Subacute Exacerbation				
Number of eyes examined	6	..	..	6
Number with angle partly closed	3	..	..	3 (50%)
Number with angle closed	3	..	..	3 (50%)
Secondary Glaucoma				
Number of eyes with secondary hypertension or secondary glaucoma	..	..	13	13
Number with angle open	..	..	8	8 (61%)
Number with angle partly closed	..	..	2	2 (15%)
Number with angle closed	..	..	3	3 (23%)

COMPARISON OF FINDINGS BY THORBURN AND WERNER

Thorburn [5] in 1927 studied with the contact glass, a loupe and a flashlight twenty-one eyes with primary glaucoma. In six eyes the glaucoma was of the congestive type: Two had total scleral synechia and one total trabecular synechia; in three the angle was open. Of nine eyes with simple glaucoma, six had an open angle, in one there was partial scleral and in two partial trabecular synechia. Of six eyes with absolute glaucoma, four had a closed angle after congestive attacks

4. For details of the clinical histories of these cases see the original paper.[2c]

5. Thorburn: A Gonioscopical Study of Anterior Peripheral Synechia in Glaucoma, Dissert., Stockholm, 1927.

and two an open angle, being of the simple type. Of nineteen partner eyes, sixteen had an open angle, one had total scleral synechia after congestion and the remaining two had partial synechia.

Werner [6] in an excellent paper reported the gonioscopic examination of normal and glaucomatous eyes with a modified technic. He used the Koeppe contact glass and made the examination with the Gullstrand corneal microscope held in his hands. The illumination was achieved with the light of an electric ophthalmoscope or with a torch. He chiefly employed magnifications of 15 ×. He examined thirty-four eyes with nontreated primary glaucoma. Of these one had an acute congestive attack with annular trabecular synechia, and two had the chronic congestive type with partial scleral synechia. In twenty of the twenty-eight eyes with simple glaucoma the angle was entirely open, while eight had peripheral synechia, scleral in six and trabecular in two. Included among these twenty-eight eyes were two with juvenile glaucoma. In three eyes with absolute glaucoma at a late stage of the simple type, the angle was closed by trabecular synechia in one and open in two. Of eleven partner eyes ten had the angle open all around, while in one there was annular trabecular synechia.

From this material Werner concluded that peripheral synechia is usually found in congestive glaucoma, while in the simple form the angle is almost always free.

He also studied sixty glaucomatous eyes which had been treated with miotics. Of these, five had acute congestive glaucoma (two had total scleral and three trabecular synechia); forty-nine had the simple type, thirty-nine with an open angle and ten with peripheral synechia (scleral in one, trabecular in nine), and six had absolute glaucoma, one of the congestive type with a closed angle and five of the simple type with an open angle.

Werner's findings are somewhat different from mine. In acute congestive glaucoma I found the angle open in 26 per cent of the cases, while Werner found it always closed: in one eye of his nontreated series and in five eyes treated before the examination. However, in the former, the synechia was only trabecular, all around the limbus; i. e., the angle was not entirely closed. In the chronic congestive form, in two eyes of his nontreated series he found the angle closed, in one eye by trabecular and in the other by scleral and trabecular synechia, while my own statistics show that the angle was open in 25 per cent and closed totally or partially in 75 per cent.

This difference can probably be explained by the good opportunities I had to observe many eyes with acute or subacute glaucoma immediately

6. Werner, Sigurd: Gonioskopische Untersuchungen bei Glaucoma primarium, Acta ophth. **10**:427, 1932.

before or just after the attacks, while Werner examined only six eyes of this type.

In chronic simple glaucoma, however, our findings are almost alike. Werner saw the angle open in the great majority of cases in his two series, even in a larger proportion than I did in my own. Of thirty eyes of his nontreated series, twenty-two (73.3 per cent) had an entirely open angle and eight a closed angle (26.6 per cent). Of forty-nine eyes of the treated series, thirty-nine had an open angle (79.5 per cent) and ten a closed angle (20.4 per cent), while my own statistics show that the angle was open in 55.8 per cent, partly closed in 38.2 per cent and entirely closed in only 5.8 per cent.

An interesting finding in Werner's series was in his treated cases: six eyes with absolute glaucoma, of which five (83 per cent) had an open angle.

Werner asserted that he never found that anterior peripheral synechia could develop in the course of simple glaucoma during the miotic treatment, or that synechia already formed could increase, although the glaucomatous process had progressed in many cases. I, on the contrary, have observed many cases of simple glaucoma in which, especially when congestive symptoms appeared, although not always, the angle started to close on one or several sides and the synechia increased and became scleral at the same time that the glaucomatous process advanced. In support of this assertion I will report the following cases:

CASE 1.—This was an instance of simple glaucoma of both eyes. Mrs. M. E. had failing vision, especially in the left eye, and occasional pain or irritation of both eyes. When she was first seen at the clinic, in April 1932, vision in the right eye was 20/100 with correction. The pupil was sluggish; there were peripheral opacities of the lens and deep glaucomatous excavation. There were drusen in the macular region. The visual field was restricted to an island around the fixation point. The tension was 31. In the left eye vision was 20/40 with correction. There were equatorial opacities of the lens and a glaucomatous cup with a narrow rosy rim nasally. The visual field showed slight peripheral contraction. The blindspot was normal. The tension was 22. In June, the tension was 35 in the right eye and 25 in the left. On July 5, gonioscopy showed annular trabecular synechia in both eyes (fig. 1*A*). The left visual field had a marked Bjerrum scotoma upward. In September, the tension in the right eye had risen to 40 in spite of the use of 2 per cent pilocarpine in both eyes. The pupil was slightly dilated; there was weak orbital pain. Treatment with 0.5 per cent physostigmine was instituted. On November 10, gonioscopy gave the result shown in figure 1*B*. No operation was advised for the right eye on account of the great restriction of the visual field. Operation on the left eye was not accepted. The patient did not return to the clinic.

In this patient an annular trabecular synechia was changed into a scleral one on three sides, while it was detached above. It is probable that the trabecular synechia above was not yet permanent and could be

detached by the action of physostigmine, while in the other parts the advancing glaucomatous process closed the angle entirely.

CASE 2.—Mrs. G. F., in March 1932, when examined at the clinic, asserted that for seven years she had had attacks of pain with halos and failing vision in the right eye. At that time she had an acute exacerbation, which was treated with miotics. In April 1932, a trephine operation was done in this eye. The left eye appeared normal. When I examined her in March 1933, the right eye was almost blind. There was total deep excavation in the disk. The tension was 38. Later, hypotony ensued.

In the left eye the course of the disease was interesting. In March the eye appeared normal. Vision was 20/30. The tension was 22. There was a small, seemingly physiologic excavation in the disk. The visual field, both peripheral and central, was normal. Gonioscopy performed at that time showed the angle narrow but open all around (fig. 2 *A*).

In May the tension rose to 33 with slight diminution of vision. The use of pilocarpine (1 per cent) at night was ordered. The tension became normal and

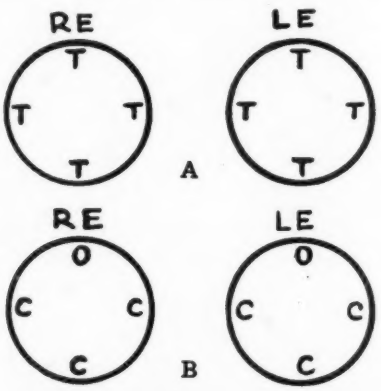


Fig. 1 (case 1).—*A*, result of examination of the angle of the anterior chamber with the gonioscope on July 5; annular trabecular synechia. *B*, result of gonoscopy on November 10 following treatment with 0.5 per cent physostigmine.

The use of circles or squares to show graphically the condition of the angle has the advantage that it points out at the same time the length and the depth of the peripheral synechia. A letter appended to a part of the circle shows the condition of the angle at that place only, and gives, in addition, the depth of the peripheral synechia when this exists. *O* means that the angle is open; *T*, that the synechia is trabecular (i. e., the root of the iris advances to the trabecular zone); *C*, that the synechia is scleral (i. e., the edge of the iris reaches forward to the apparent corneoscleral junction). In former papers the last condition was designated by *S* on account of its gonioscopic aspect, the white scleral band being covered by the iris, but anatomically it is a corneal synechia because the edge of the iris reaches forward and is adherent to the inner corneal surface.

continued so until March 1934, but when the use of pilocarpine was eventually discontinued the tension immediately rose to about 31. The visual fields were still normal, but the central excavation of the disk appeared larger and deeper. A general examination disclosed hypertension and traces of albumin in the urine. There was no enlargement of the thyroid. Obesity was a feature. In May the

excavation in the disk was increased, two vessels being clearly kinked on the upper and lower edge at the center. Vision was 20/30. The blindspot was normal. In October the patient had discontinued the use of miotics for two months. Gonioscopy showed trabecular synechia nasally and downward (fig. 2*B*). The visual field showed slight peripheral contraction. Iridectomy was advised but not accepted. Miotics were used. In November the angle showed an increase in the peripheral synechia to the temporal side (fig. 2*C*). Iridectomy was performed on December 12. On December 24, the tension was 24. Gonioscopy after the operation showed the iris removed entirely, although at the upper part of the pillars the retinal layer of the iris had been separated from the stroma. From it a narrow black projection went up to the inner scar of the sclera. The trabecular synechia had been detached except at the nasal side (fig. 2*D*).

The slow increase in the excavation of the disk in the left eye and the lack of congestive symptoms point to a beginning simple glaucoma in this eye. The onset and extension of a peripheral synecha were clearly observed with the gonioscope.[7]

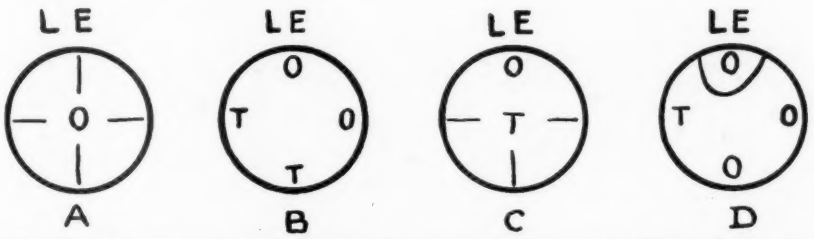


Fig. 2 (case 2).—*A*, angle narrow but open all around in March 1933; treatment with miotics. *B*, trabecular synechia nasally and downward in October 1934, following discontinuance of use of miotics for two months. *C*, in November, peripheral synechia increased to temporal side. Iridectomy was performed on December 12. *D*, on December 24, root of iris entirely removed; trabecular synechia detached except at nasal side.

PERIPHERAL SYNECHIA AND HEIGHT OF INTRA-OCULAR PRESSURE

One of the most interesting facts which gonioscopy has disclosed is the lack of correspondence between the height of the ocular pressure and the condition of the angle.

With an open angle the pressures may vary from normal to as high as 50 or more. In my first paper I described a case of simple glaucoma (case 15) in which in spite of prolonged treatment with miotics the tension rose to 45 with an open angle. In my second paper I described the partner eye in a case of acute glaucoma (case 1), which had a tension of 30 with an open angle. In my third series the tension varied from 22 to 47 in cases 2, 4, 5, 19 and 32, in all of which the angle was entirely open. In case 7 the right eye had subacute glaucoma with a tension of

7. The clinical histories of cases 3 to 7 have been suppressed on account of lack of space.

25 and scleral synechia on two sides, the other two being open, while the left eye with annular scleral synechia had 78 mm. of pressure, which came down to 26 after iridectomy, the synechia remaining in the same condition. On the other hand, in a case of chronic congestive glaucoma (case 9) the angle was closed on three sides with scleral synechia while the tension was only from 16 to 22.

Werner tabulated data on twenty eyes with simple glaucoma and two with glaucoma absolutum-simplex in all of which, with an open angle, the tension varied from 22 to 67 in the former and from 55 to 95 in the latter, the average being 41.8.

These figures refer only to the date of observation, but in the same eye, with an open angle, the tension may vary as much as 10 or 20 mm. from day to day, especially when congestive symptoms appear. This clearly shows that the cause of hypertension is not the closure of the angle, as I have emphasized since 1925.[2a]

On the other hand, there is no direct relation between the size and width of the peripheral synechia and the height of the intra-ocular pressure. A high figure may be found with either trabecular or scleral synechia.

In case 12 of my third series, a case of chronic congestive glaucoma, both eyes had total scleral synechia. In the right eye a subacute attack sent the pressure up to 70 while in the left it stayed around 21 for months. In case 15, also one of chronic congestive glaucoma in the left eye, with scleral synechia all around except on the outside, the tension changed during the period of observation from 22 to 31 to 40, when the use of pilocarpine was discontinued.

Werner tabulated data on twelve eyes, three with congestive, eight with simple and one with absolute glaucoma, in which trabecular and scleral synechia existed without any correspondence with the amount of ocular pressure, which varied from 27 to 67.

One may conclude, then, that the formation of a partial or a total peripheral synechia during the time of observation shows only that the glaucomatous process is advancing and that the ciliary processes are edematous and have pushed the root of the iris forward. A vicious circle is thus started, the gradual closing of the outlet at the angle helping to increase the retention of the fluids in the anterior chamber. The Schlemm canal is not, fortunately, the only way of escape of the fluids; the veins of the iris and even, perhaps, in some extreme cases the ciliary body itself may help in the absorption. Thus when equilibrium fails, nature always starts a compensatory mechanism, which may or may not be successful in bringing about a balance of the disturbed function.

SIZE OF PUPIL AND ITS BEARING ON THE ANGLE

Werner showed in a study of twelve eyes with congestive and twenty-two eyes with simple glaucoma that the size of the pupil has no influence in the formation of peripheral synechia or in its size and width. A large pupil does not correspond to a wide synechia or a smaller pupil to a trabecular one. An open angle may be present with wide pupils, 5 by 5 mm. or 7 by 7 mm., or with contracted ones, 3 by 3 mm.

In case 2 of my third series with congestive glaucoma, the pupil of the left eye was oval and drawn upward. However, gonioscopic examination showed that at the upper part of the limbus there was only a small trabecular synechia instead of the wide scleral one which the shape of the pupil suggested. In a prolonged course of treatment with miotics even this narrow synechia disappeared, while the oval shape of the pupil remained. This deformation of the pupil was probably due to an atrophy of the iris, with proliferation of the fibroblasts and formation of a fibrous membrane which at a certain point splinted the iris and rendered it immobile, while the rest still contracted (Reese).

Werner also made interesting gonioscopic examinations of the action of miotics and mydriatics in the closure of the angle in normal and in glaucomatous eyes, and found that mydriatics narrow the sinus but do not close it entirely, as some authors have asserted. He also saw (as I had already stated) that miotics used in the beginning of glaucoma can detach the adhesion of the root of the iris to the cornea in some cases. Among nine eyes he saw the synechia completely loosened in two eyes, partially in four and not affected in three. The intra-ocular pressure was lowered by miotics in all these cases, although the sinus of the chamber remained occluded by the synechia.

II. CONDITION OF THE ANGLE AFTER OPERATIONS AND ITS SIGNIGFICANCE

What has gonioscopy taught in regard to the effect of antiglaucomatous operations on the different structures of the angle? If it is remembered that this region of the anterior chamber is the usual pathway through which the major operations on the eye are performed, it is evident that an examination from the inside in the living eye after the surgical procedure will give the ophthalmologist important data not only from the surgical but also from the clinical standpoint.

Before the advent of gonioscopy surgeons had to guess about the results of their operations on the different structures. It is true that in some cases microscopic examinations of enucleated eyes had given some data on the postoperative results and complications, but as the eyes were in such a serious condition that they had to be removed it is open to doubt whether some of the findings were present in earlier stages.

Gonioscopy has greatly contributed not only to the detection of these changes but also to the eradication of guess-work and has given a firmer foundation to the different theories in explanation of the physiopathology and manner of action of the different surgical methods.

IRIDECTOMY

Since von Graefe's discovery of iridectomy as a cure for acute glaucoma, many theories have been set forth to explain its good results. It will be impossible to mention all of them in this paper. The reader is referred to the large encyclopedias and monographs dealing with the subject.

One of the most extensively held ideas is that iridectomy acts by reopening the angle of the anterior chamber closed by the glaucomatous process. This is the old explanation of Weber,[8] which was brought out almost at the same time that Knies discovered the peripheral synechia. He believed that the detachment of the iris adhesion reestablished the outflow. When the time had passed that this could be done, the synechia being permanent, the effect was nil. This was also the opinion of Czermak,[9] who thought that iridectomy by cutting off the pectinate ligament made a direct communication between the anterior chamber and the Schlemm canal easy. Fuchs [10] asserted that after permanent closure of the angle iridectomy can do no good, except when a filtering scar is produced. These statements had no support in facts. Nobody had seen whether or not the normal outlets had been reestablished in cases in which the operation had been successful or vice versa.

Since the publication of my first paper on gonioscopy [2a] I have pointed out that the reopening of the angle is not a necessary condition for the success of iridectomy. In case 9 of the first series [11] the left eye of a patient suffering from acute glaucoma had a tension of about 100, with the anterior chamber almost abolished. After physostigmine had been used for four days, the chamber being still very shallow, a posterior sclerotomy was performed before the iridectomy. The tension immediately came down to 17. Gonioscopy disclosed total scleral synechia persisting after the operation. Commenting on this case I wrote:

> It is a matter for speculation how iridectomy worked in this eye. Notwithstanding the total peripheral synechia, the eye drained its contents perfectly, if we may judge by the lowering of the tension, which was reduced to and remained

8. Weber, A.: Die Ursachen des Glaukom, Arch. f. Ophth. **23**:1, 1877.

9. Czermak, Wilhelm: Augenärztliche Operationen, Vienna, C. Gerold's Sohn, 1898, p. 181.

10. Fuchs, E.: Text-Book of Ophthalmology, ed. 7, translated by Alexander Duane, Philadelphia, J. B. Lippincott, 1923, p. 799.

11. Troncoso,[2a] p. 445.

around 17 mm. The iridectomy was not broad and in its base the extent of the Schlemm zone which was restored to filtration small. The scar of the operation was solid and nonfiltrating. The stroma of the iris was clearly atrophic and the veins probably degenerated and occluded by the adhesion at the root.

In another case of the first series (case 10) there was total scleral synechia in both eyes, which persisted after iridectomy. The tension lowered immediately in both eyes, but the right eye later had another attack of glaucoma.

In my second series, in case 6,[2b] of chronic congestive glaucoma with annular scleral synechia, both eyes were observed only after the operation; annular scleral synechia was detected, although the tension had become normal.

In case 7 of the third series,[2c] one of chronic congestive glaucoma, the left eye, examined with the gonioscope, showed a totally closed angle with scleral synechia. A few days later an acute attack developed, with 78 mm. of pressure. An iridectomy was performed which entirely relieved the pain and the tension (26 mm.) although vision remained bad. A second gonioscopic examination disclosed no change in the condition of the angle.

There were other cases, however, in which iridectomy was done earlier, when part of the angle was still open or when the root of the iris was only mechanically applied against the cornea. In those instances the operation succeeded in detaching the synechia, at least in part. In five eyes of the third series all with congestive glaucoma iridectomy gave the following results:

CASE 9.—The angle of the left eye was almost closed. It was reopened in one side by iridectomy. The tension stayed normal.

CASE 10.—The right eye was examined only after iridectomy; the angle exhibited two sides still open and the other two closed. The tension was normal.

CASE 13.—The patient was subjected to gonioscopy before and after iridectomy. The angle, closed in three sides by scleral synechia, was entirely reopened, a very rare occurrence. The tension remained normal.

CASE 14.—The angle of the left eye was entirely closed before the operation. It was reopened in two sides by iridectomy. Hypertension recurred intermittently, but only miotics were used.

CASE 16.—An acute attack of glaucoma in the left eye was treated by iridectomy one year before; the eye still showed the angle open in two sides. The tension was normal.

I must mention in passing that in none of these cases was there a further closing of the angle after the operation.

It was also interesting to watch the effect of iridectomy in cases of simple glaucoma in which the angle was open before the operation. In four cases of the third series, with the angle open, there was no change after the operation, although the tension was reduced (cases 19, 21, 22 and 37).

In case 38, one of simple glaucoma and diabetes, the angle, which was entirely closed before, had one of its sides reopened by iridectomy. The tension came down, but vision became worse.

Werner described in his clinical material eleven eyes operated on by iridectomy, of which five were examined by gonioscopy before and after the operation and six only after. Of the latter group three eyes showed acute glaucoma; the angle was closed all around by scleral synechia, and the tension was low. The other three eyes, also with acute glaucoma, had annular scleral synechia before the operation. In one of them it was detached at the place of the coloboma; in the other two the synechia changed to trabecular on the temporal side while on the nasal it was detached.

In the first group, one eye with chronic congestive glaucoma had scleral and trabecular synechia, and after the operation the former changed to trabecular. In four eyes affected with simple glaucoma which had been operated on many years before, gonioscopy showed that the angle was entirely open, but the tension had not lowered.

From the cases reviewed one may conclude: 1. The reopening of a closed angle is not necessary for the success of an iridectomy in acute glaucoma. 2. This operation succeeds in lowering the tension and in many cases improves vision even when the angle remains totally closed. 3. The detachment of the peripheral synechia from the cornea, although beneficial to the nutrition and function of the eye, is not a condition sine qua non for the reestablishment of the outflow even when a nonfiltering scar is present. 4. In eyes with simple glaucoma and with the angle open, iridectomy may be successful in lowering high tension although no change has been wrought in the condition of the angle. 5. Although peripheral synechia is not the cause of glaucoma, its presence means an added difficulty for the outflow of liquids from the eye.

One may ask oneself, then, in what way iridectomy acts to relieve hypertension, improve the whole condition of the eye and sometimes vision in primary congestive glaucoma.

A clue may be found in the condition of the vitreous, i. e., in the increase of the posterior over the anterior pressure which makes itself manifest especially in the acute attacks by the forward movement of the iris-lens diaphragm and the narrowing of the anterior chamber, which in some cases is reduced to a slit.

This difference is proved clinically by the results of posterior sclerotomy in acute glaucoma. In normal eyes aspiration of the vitreous with a syringe is difficult and does not give any liquid, while in glaucoma the aperture of the sclera drains a large amount of yellowish fluid.

To my mind the principal action of iridectomy is the reestablishment of a free communication between the anterior and the posterior segments of the eye. This is an old idea.

Bowman [12] believed that the aperture made in the iris by exposing the zonula facilitated the passage of the fluid from the vitreous to the anterior chamber, where it was absorbed by osmosis. Ulrich [13] had the same opinion. He thought that in glaucoma the iris membrane became waterproof, so that the passage of the aqueous to the anterior chamber was interfered with, hence hypertension. The operative aperture of the iris reestablished the equilibrium of fluids between both chambers and relieved the pressure. Coccius [14] and then Leber supported the idea that the excision of the iris helped the free circulation of fluids between both chambers.

This theory, however, lost ground and was rejected in favor of the deceptive explanation of the reopening of the angle. What, then, are the mechanical principles involved when with total scleral synechia excision of the iris relieves the hypertension? If I may be allowed to make a rough comparison I shall point out what happens to the large election posters drawn across the street and to some commercial billboards. Even if they are made of strong material, a high wind invariably throws them down. But if holes are made through the posters and they are of proper size and in sufficient number to allow the wind pressures on the two sides to be equalized, the signs and the posters will stand any kind of weather without mishap.

It is probable that the same thing happens in the eye during the glaucomatous storm when the posterior pressure becomes much higher than the anterior. If the iris is intact the posterior pressure will overcome the anterior, but if a large hole is made in the iris, the pressures on both sides of the membrane will tend to equalize.

In acute glaucoma the communication between the two chambers is blocked, besides, by the tight application of the capsule of the lens to the posterior surface of the iris around the pupil. This valvelike action offers a greater and greater resistance to the passage of fluids from the posterior to the anterior chamber owing to the compression of the aqueous.

Several observers (Merkel,[15] Duke-Elder,[16] Moreno [17]) have shown that the interstices between the zonular fibers (the perilental space) are

12. Bowman: Discussion on the Value of Iridectomy in Glaucoma, Tr. Internat. Cong. Ophth., London, 1872, p. 194.

13. Ulrich: Die Pathogenese des Glaukoms, Arch. f. Ophth. **30**:235, 1884.

14. Coccius: Ueber Glaukom Entzündung und die Autopsie mit dem Augenspiegel, Leipzig, I. Müller, 1859.

15. Merkel, F. S.: Die Zonula ciliaris, Leipzig, Wilhelm Engelmann, 1871.

16. Duke-Elder, W. S.: The Nature of the Vitreous Body, Brit. J. Ophth., monogr. supp. 4, London, George Putnam & Sons, 1930.

17. Moreno, J.: La zonula ciliar, Arch. de oftal. hispano-am. **33**:235, 1933.

not empty but filled with a clear jelly-like substance similar to the vitreous. If this substance suffers the same glaucomatous changes as the vitreous itself and becomes swollen or edematous, the ring around the edge of the lens, the narrow perilental space, will offer a great resistance to the transmission of fluids and help to increase the posterior pressure.

To my mind iridectomy works in several ways: (1) by providing a large aperture between the chambers which allows the liquids of the eye to circulate freely and equalize the pressures on both sides of the iris-lens diaphragm; (2) in some cases, by reopening the normal outlets of the chamber blocked by anterior peripheral synechia; (3) by relieving the pressure on the veins of the iris and ciliary processes and permitting the absorption of the aqueous in larger quantities; this effect is greater, of course, when the adhesion of the root of the iris to the cornea is detached; (4) by opening a new, although small, outlet to excretion through the edges of the coloboma, which never are cicatrized (Henderson).

It has always been considered sound surgery to make a large coloboma in cases of congestive glaucoma. This is in entire agreement with the ideas stated before. On the other hand, partial iridectomies which allow the sphincter to remain (especially when an iritis, even slight, supervenes) have much less marked effect.

It is also the common opinion that an iridectomy, to be more successful, should be performed by tearing the root of the iris from the angle. It is expected in this way to detach the synechia and open the outlet. When I began to examine with the gonioscope eyes on which iridectomy had been performed I was struck with the frequency with which the root of the iris remained in the angle. The operation seemed perfect and the coloboma complete by ordinary inspection with the loupe, but with the gonioscope a strip of iris tissue appeared above.

In some cases the angle was free, and it was really the root of the iris which was left behind. In others, when scleral peripheral synechia existed, the adhesion was not detached and the iris had been cut, leaving a rim of tissue below the synechia. However, as pointed out before, the operation was as successful in relieving the high tension in one as in the other case.

The detachment of the synechia at the place it has developed should be tried by pulling the iris away from its insertion with the forceps during the operation. However, the practice of tearing the root of the iris, as von Graefe recommended long ago, produces a greater trauma than the simple excision and may originate a large hemorrhage in the anterior chamber. There is no reason to attempt it when the angle has been shown by gonioscopy to be open at that place.

After some iridectomies the iris may be cut through entirely, and the ciliary body band and processes appear in all its breadth, or the synechia may remain. One or both edges of the coloboma may become incarcerated in the wound. If this incarceration is small, it may not show in any way outside, nor produce any filtering scar.

Indications for Iridectomy.—Almost everybody agrees that iridectomy is the operation of choice in cases of acute glaucoma. It gives uniformly good results. The great majority of surgeons perform it also in cases of chronic congestive glaucoma, but its success is variable according to the conditions of the eye. Failures ascribed to iridectomy are due in part to the fact that the operation was performed at a late period when degeneration of the iris and ciliary processes and probably great changes in the vitreous and atrophy of the nerve had set in with the angle entirely closed.

In selecting an operation for any type of glaucoma it should be remembered that it does away only with the increase of tension and does not have any effect on the original cause of glaucoma. In the acute type, iridectomy usually cures the attack and prevents new ones, leaving the road open for the equalization of pressures if they become unbalanced. In the chronic congestive type, along with the tension, one should consider the condition of the optic nerve and particularly the field of vision as well as the condition of the angle. Iridectomy is still the operation of choice in early cases. Its effects will be better if the angle can still be reopened in part at least. Cyclodialysis has also a beneficial effect in some instances. In cases of chronic, advanced glaucoma, when the angle is entirely closed and the eye degenerated, fistulization is the last resource.

In the treatment of simple glaucoma iridectomy should be used if miotics fail, if the visual field narrows, the scotoma advances steadily, and the angle starts to close. It deals only with the minimum attacks of congestion which increase the tension.

THE MECHANICAL CONCEPTION OF OPERATIONS FOR GLAUCOMA

Many ophthalmologists consider an operation for glaucoma successful when the ocular tension has been lowered to normal or below normal, even in cases in which vision continues its downward trend, the visual field narrows still more and degeneration of the structures sets in and progresses. It is rarely that in the statistics collected by several surgeons showing the results of different operations the condition of vision and the visual field are mentioned side by side with the height of pressure.

If a first operation fails to lower the tension, many surgeons do not hesitate to do a second or even a third in short periods of time. In

my opinion there is need to react against the idea that the treatment of glaucoma is simply a mechanical problem, a question of hydrostatics. The tonometer should not be made the sole judge for the necessity of operation, but the whole picture of the disease of each patient must be carefully considered.

The surgeon should always wait at least until all inflammatory reaction has subsided, and it would be wiser to wait even longer, giving nature time to readjust the functions of the eye and bring into play the fine compensatory mechanisms which will balance the new conditions of intra-ocular pressure. After several operations the tension may have been mechanically lowered, but the functions of the eye are frequently greatly impaired and vision lost.

The following cases are illustrative of this point of view:

CASE 3.—*Chronic Congestive Glaucoma* (*Case 14 of Third Series*[2c]).—Mr. O. M., 60 years old, had an attack of acute glaucoma in the right eye nine or ten years ago, and vision was later completely lost. The left eye had been in good condition until May 2, 1930, when suddenly it became painful and red. On examination, June 13, the right eye was found to be suffering from absolute glaucoma. The eye was atrophic and soft, with no perception of light. In the left eye the tension was 50. There was redness; the pupil was large, the anterior chamber shallow, the iris discolored, and the disk excavated in the upper part. The visual field showed the blindspot slightly enlarged. Gonioscopy revealed annular scleral synechia around the limbus (fig. 3 *A*).

Treatment with physostigmine was begun, and on June 22 the tension was 22 and vision was 20/20; the pupil was still large. An iridectomy was done on July 9. On July 31, the tension was 20, the eye quiet, and vision was 20/30. Gonioscopy of the left eye revealed that the root of the iris was still adherent to the sclera. Its borders were ragged and white. Pigment dust had gathered on the upper border of the lens. The scleral synechia did not detach with the pulling of the iris above, and the excision left a strip of the tissue attached to the wall. The synechia, however, had been detached in the lower and probably in the temporal part, where a faint brown black line appeared (fig. 3 *B*).

Immediately after gonioscopy the eye became very red, and slight chemosis of the conjunctiva appeared. This was controlled with physostigmine and an epinephrine pad.

On August 26, the eye appeared normal. With cyl. +2 diopters, axis 165°, vision was 20/20. The tension was normal. The use of pilocarpine twice a day was advised. On October 13, the patient came back with slight redness of the eye. There was no pain. The tension had risen to 36. Physostigmine brought the tension down to normal in a few weeks.

The patient was under observation for several months, with mild recurrences of hypertension, which were kept well under control. On October 26, 1931, he had a subacute attack with the tension 48. The excavation of the disk had increased above, with two vessels making a sharp hook. Vision was still 20/20. The advisability of an operation (cyclodialysis) was explained to the patient, but he decided to wait. Treatment with myotics continued.

In July of the following year the condition was the same. The left eye had a tension of 25, with no redness. In October the patient had a cold and financial

worries. The tension rose to 34. The excavation slightly increased. With a new correction, vision came up to 20/20. In December he complained of bad adaptation to light on coming from darkness. The eye, however, seemed to have adjusted itself to higher tension (35 mm.). There were no halos and no redness, and he performed his duties well. The blindspot was enlarged downward. During the whole year of 1933 the eye remained in the same condition with oscillations of tension between 25 and 31, and vision was 20/20, although foggy at times. Pilocarpine was used faithfully.

He was not seen again until in June 1934. He complained of blurring in the center of the visual field which would clear up and then vision would fade again. He had no pain and no halos; vision was 20/20 —4. The excavation was now complete, the rim of reddish tissue above having disappeared. The nerve was somewhat pale. The tension was 25. In Nov.ember 1934, vision was 20/20 — 4, and tension was 23. The eye was quiet. Gonioscopy gave the same picture as in 1930. The adhesion of the iris to the scar persisted. The angle was still open below.

This patient was observed for four years after iridectomy. He remained comparatively well in spite of several recurrences of tension. Central vision stayed good, although Seidel's scotoma greatly increased.

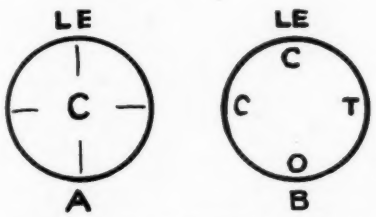


Fig. 3 (case 3).—*A*, annular scleral synechia around the limbus on June 13. *B*, result of gonioscopy on July 31 following iridectomy on July 9.

If a trephine operation had been done, the vision probably would have been entirely lost. On the other hand, the history of the patient in case 4 (communicated to me) illustrates well the danger and futility of repeated operations.

CASE 4.—Mr. J. W. (case 17 2d), 28 years old, had pain and dimness of vision in the right eye in December 1931. A specialist diagnosed glaucoma and began treatment with pilocarpine. On April 6, 1932, vision in the right eye was 20/200; the tension was 60; the eye was red and uncomfortable, the pupil dilated and fixed; there was deep excavation of the disk, with a halo. With the slit lamp, edema of the cornea, floating cells and pigment in the aqueous and pigment deposits in the anterior capsule of the lens were noted. There were no traces of iritis or of posterior synechia. The visual field was reduced to a large island around the fixation point and temporally. A diagnosis of simple glaucoma with acute exacerbations was made, and a trephine operation with basal iridectomy was practiced on April 8. Healing was uneventful. On April 18, the tension was 18. The patient was seen again on September 28; the tension had arisen to 52, and the eye was congested. Pilocarpine and an epinephrine substitute (glaucosan) were administered. On November 23, a second trephine operation was done to the right of the old coloboma, with a button-hole iridectomy. After this second operation the tension did not lower (40); vision decreased to 20/100. As the eye

remained red, though not painful, a third trephine operation was done at about 1:30 o'clock with peripheral iridectomy. Iritis developed with posterior synechia. In May 1933, tension remaining high, a cyclodialysis was performed detaching the ciliary body from 6 to 10 o'clock. Considerable chemosis and injection followed, and the tension came down, but in August it was high again, vision was almost lost, and only a small island persisted in the temporal side of the visual field.

Three trephinings and one cyclodialysis failed to bring the tension down permanently. The patient did not benefit, as the vision was almost lost and the inflammation and pain were not relieved. After each operation there was a protracted reactive inflammation and thus a bad element was added to the old glaucomatous process.

FISTULIZATION

This method of treatment is based on the assumption that the normal outlets in the anterior chamber are so hopelessly damaged and occluded that a new permanent way of excretion has to be devised to allow the increase of the intra-ocular fluids to flow out of the eye. This new outlet is supposed to be obtained by the formation of a fistula through the sclerocorneal limbus.

It is peculiar, however, that trephining has been applied mainly to chronic simple glaucoma, for which it is considered the operation of choice and concerning which the gonioscopic findings have shown that the angle is entirely free in the great majority of cases. Thus, although the normal outlets are usually working, a "permanent drainage" has been established and superimposed, even if the ocular tension is not permanently high. In cases of chronic congestive glaucoma, in which the angle is usually partly or totally closed, fistulization has a more logical application, but even in these cases it is fraught with added danger to the eye. It is well to examine more closely the physiopathologic basis of this operation. A hole is made in the sclerocorneal limbus to tap an overfilled reservoir. To provide for the regulation of the amount of outflow, there is a spigot: the episcleral space and the conjunctival cover. It is supposed that this fistula takes care of the excess of fluids contained in the globe, allowing them to leak into the subconjunctival space. Although there are undoubtedly many cases in which an equilibrium is obtained and the intra-ocular pressure stays around normal figures, in the majority of cases two things may happen to the fistula: 1. It may narrow or close altogether and the ocular pressure rise again. 2. The scleral aperture may remain widely open and a greater amount of aqueous than necessary leak out, with the result that the ocular pressure lowers until the eye becomes permanently hypotonic. In both cases the purpose of the operation is defeated.

There is not, unfortunately, any way of controlling the amount of leaking. The size of the hole has not much influence, as usually cicatri-

zation reduces its lumen or closes it. Besides there are other cases (40 per cent according to some authors) in which the spigot fails to deliver the liquid to the proper container, the subconjunctival space, and the aqueous pours freely outside on the conjunctival sac. A free fistula is thus formed which becomes a great menace, the danger of late infection lurking always in the background.

The condition of the hypotonic eye, even with a well protected bleb, is not safe. Although some authors claim that vision does not decline, there is no doubt that the nutrition and functions of the globe are impaired. The situation is highly reminiscent of the one which occurs in other corneal fistulas, viz., after perforation of the cornea consecutive to ulcers, prolapse of the iris, traumatic fistulas, etc. If the opening persists for a long time the eye gradually perishes, the lens becomes opaque, the retina detaches or an inflammation sets in leading to atrophy.

The occurrence of iritis or iridocyclitis is very common after Elliot's operation, while after iridectomy it is very rare. It represents a real danger for the eye, which adds to the gravity of the glaucomatous process. I will deal with it further.

In a previous paper,[2d] with Dr. A. B. Reese, I have described a number of unsuspected mechanical complications frequently found with the gonioscope after trephining operations. These are three in number: (1) incarceration of the iris in the corneoscleral wall, (2) incarceration of the ciliary processes in the scar of the operation and (3) exudations. The root of the iris may be excised in the base of the coloboma till the processes (fig. 4 *A*) or a strip of the root remains attached to the cornea (fig. 4 *B*). This strip is usually continuous, but may be cut through at the center, two lateral flaps being attached to the wall (fig. 4 *C*). One of the pillars of the coloboma may be incarcerated (fig. 4 *A* and *C*), or the root of the iris may be drawn into the scar in a tentlike fashion (fig. 4 *D*), and the coloboma below is either narrow or entirely closed by exudates (fig. 4 *D* and *E*). The ciliary processes may be pulled forward into the anterior chamber and become adherent to the scar; either isolated (fig. 4 *C* and *F*; fig. 5 *A* and *B*) or the whole row of processes may become dislocated into the anterior chamber (fig. 5 *C*).

Of twenty-nine eyes examined, fourteen (41.3 per cent) had one or several ciliary processes incarcerated in the scleral scar; seven (24.1 per cent) had incarceration of the iris; one (3.4 per cent), incarceration of both the iris and ciliary processes. Exudations in the angle were found in six eyes (20.6 per cent), and only three eyes (10 per cent) showed normal healing. However, from the clinical standpoint the eyes with exudations could be included among those with normal healing, making a total of 30.9 per cent. Marked postoperative iritis with

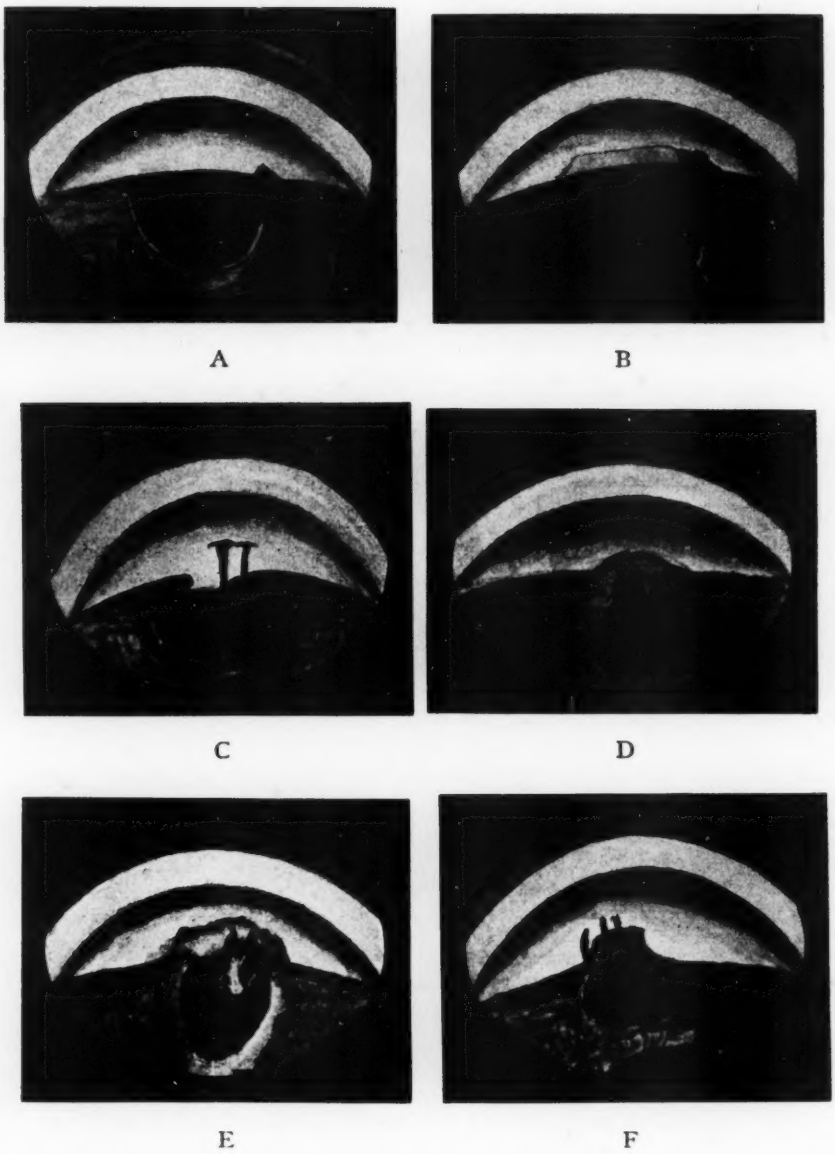
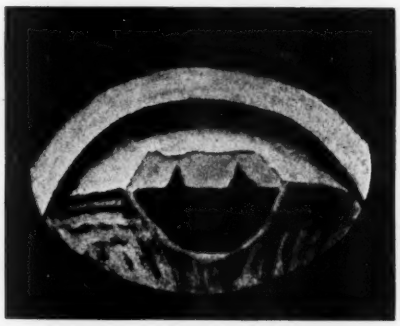


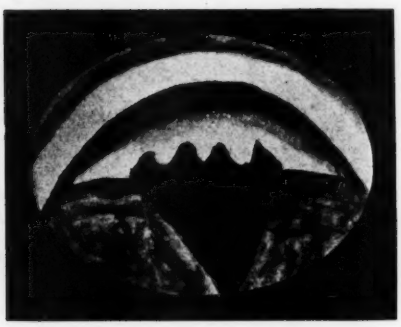
Fig. 4.—Complications after trephining operations: *A*, root of iris completely excised in base of coloboma; one pillar remains attached to cornea; *B*, strip of root and exudate attached to the cornea; *C*, strip of attached root cut through at center, two lateral flaps being attached to wall; *D*, root of iris drawn into scar in tentlike fashion; *E*, coloboma closed by exudates; two processes attached to scar; *F*, isolated ciliary processes dislocated into anterior chamber.

posterior synechia was found in seven of the twenty-nine eyes examined, or 24.1 per cent.

Werner [6] observed fourteen eyes in which Elliot's operation had been performed several years before gonioscopy. The coloboma of the partial or basal iridectomy was complete in about half of the cases, while in the other half a strip of the iris root had been left. In two eyes the iris was drawn into the scar in a tentlike manner, and the coloboma was closed.



A



B C

Fig. 5.—Complications after trephining operations: *A* and *B*, isolated ciliary processes dislocated into anterior chamber. *C*, whole row of processes dislocated into anterior chamber.

The scar was seen in the corneal wall as a depression or as a bluish water-like or edematous spot, and lay in all cases immediately in front of Schlemm's zone.

Of the fourteen eyes examined, in only three was the angle found open after the operation. In the other eleven (78.5 per cent) there were large, mostly scleral synechiae, located especially in the upper part of the angle.

Werner did not mention an incarceration of the ciliary processes into the wound such as Dr. Reese and I have found.[2d]

Werner also concluded that the synechiae formed after trephining have no significance so far as the action of the operation on the intra-ocular pressure is concerned. This had to be expected when the hole remained open, as the outflow from the eyes is not dependent any more on the natural channels of excretion.

These complications led us [2d] to believe that when a small aperture is made in a glaucomatous eye the sudden gush of aqueous at high pressure pushes the iris and the ciliary processes behind it into the hole. After the operation the processes may or may not remain entangled in the wound, according to their distance from the hole. It is a well known fact that in subacute congestive glaucoma the swollen processes are almost right behind the iris, while in cases of advanced chronic glaucoma with atrophy of the membranes the ciliary processes recede, while the iris remains attached to the cornea, both degenerating and becoming thinner.

Thus, it is not strange that the iris and ciliary processes remaining near the hole and insufficiently protected by the conjunctival cover may become infected, whence arise the frequent iritis and iridocyclitis which add a new danger to the greatly overburdened glaucomatous eyes.

Werner emphasized that after trephining in cases of simple glaucoma in which the angle was open totally or partially the operation produces a more or less complete closing of the angle. The question then arises: Why should we do a trephining with all its disadvantages in cases in which the angle is open? The answer many surgeons give is that it provides the eye with a new outlet when the natural ones have failed and prevents further danger, that statistics have proved that the operation is successful in keeping down the intra-ocular pressure at least in 50 per cent of the cases, and that in only 25 per cent of the cases does the hypertension return.

To this I can reply that in simple glaucoma the outlets are pervious as the tension is not permanently high. What the surgeons call a "good result" usually refers only to the mechanical decrease of hypertension, while the glaucomatous process continues, the field contracts more and more, the excavation increases, the central vision fails, and the eye degenerates.

In my opinion, trephining should be confined to those cases in which it is impossible to reestablish the normal outlets of excretion, i. e., to cases of advanced congestive or simple glaucoma with a closed angle in which iridectomy has failed or in which this operation may be difficult to perform on account of very high tension, maximal dilatation of the pupil, atrophic iris or advanced intra-ocular changes such as thrombosis, hemorrhages, etc.

One should have in mind that any operation for glaucoma is intended only for abatement of the hypertension and that nothing is known

about the causes which produce the involvement of the nerve head and the hypertension in simple glucoma and the acute and subacute attacks in the congestive type.

IRIDENCLEISIS

I have not been able to examine the angle of the chamber with the gonioscope in any cases after iridencleisis or iridotasis.[18] Werner, who had good material in the Lundsgaard Clinic, described his findings as follows: He observed nineteen eyes, seventeen before and after the operation and two only after. Eighteen showed glaucoma of the simple type and one chronic congestive glaucoma. By gonioscopy he saw the borders of the coloboma incarcerated in the scar, usually in front of the Schlemm canal (six eyes) or in the Schlemm zone itself (seven eyes), while in only one eye had the incarceration been made far back and in front of the border of the ciliary body itself. In ten eyes with simple glaucoma the angle was free before the operation, but after it, as in trephining, the angle became entirely closed in six. Of three other eyes which had trabecular synechia before the iridencleisis, one remained unchanged and in two the synechia progressed to scleral. In all of them the intra-ocular pressure was lowered to normal, but he asserted that he did not follow them for a long period of time after the operation. In one of these eyes, four weeks after the operation, the angle was entirely closed and the patient had new severe acute attacks of glaucoma some months later.

From these cases he concluded that, as in iridectomy, the presence of extensive scleral synechia has no significance in the regulating action of iridencleisis on the ocular tension.

SUMMARY

After the discovery of anterior peripheral synechia by Knies and Weber in 1877 it was assumed that this condition was the primary cause, the origin, of hypertension in primary glaucoma. To disprove this theory, it was of no avail that in some eyes enucleated post mortem after attacks of acute glaucoma the angle of the anterior chamber was found entirely open.

When the gonioscope was devised, and the angle could be seen in living eyes at different stages of glaucoma, it was found that conditions were vastly different from those observed in old glaucomatous enucleated eyes. Salzmann, who was the first to observe glaucomatous eyes by gonioscopy, found the angle free in four cases of secondary traumatic glaucoma and partially closed in three cases of congestive

18. Other operations, such as iridencleisis and substitutes for iridectomy, will make the subject of a subsequent article.

and one of simple glaucoma. I reported in my three series, on eighty-seven glaucomatous eyes, the following results:

1. Twenty-six eyes with primary congestive glaucoma: (*a*) Of those with acute and chronic congestive glaucoma, the latter with acute or subacute exacerbations, the angle was open in 26, partially closed in 46 and closed in 26 per cent. (*b*) Of those with chronic congestive glaucoma (8 eyes) the angle was open in 25, partly closed in 25 and closed in 50 per cent.

2. Thirty-four eyes with simple glaucoma: The angle was open in 55.8, partly closed in 38.2 and closed in 5.8 per cent.

3. Six eyes with simple glaucoma with subacute exacerbations: The angle was partly closed in 50 and closed in 50 per cent.

4. Secondary glaucoma (different causes). The angle was open in 62, partly closed in 15, and closed in 23 per cent.

From these figures I concluded that in the beginning of acute glaucoma, when the attack is not very severe or when it lasts a few hours, the angle is open. If the attack persists or if relapses take place, the angle may close in part. Finally, in very severe attacks, the angle is closed all around. The succession of events proves that the closure of the angle is not the initial cause of glaucoma but only an effect of hypertension. Total peripheral synechia is the result of the edema and swelling of the vitreous and the edema of the processes which push the whole corona ciliaris forward. Partial synechia is probably due to the edema and turgescence of a limited number of processes which push the root of the iris forward at a particular place in the limbus, although a partial agglutination of the root of the iris to the cornea when the whole corona ciliaris recedes after the acute attack may also be the cause. In simple glaucoma the angle, usually open, proves also that peripheral synechia is the result and not the cause of hypertension. When the disease advances and congestive attacks appear the angle starts to close. In secondary glaucoma the angle is also open at the beginning.

Thorburn among twenty-one cases of primary glaucoma found six cases of congestive glaucoma with the angle open in three eyes, partly closed in one and closed in two. Of nine eyes with simple glaucoma, six had an open angle, and in three it was partially closed.

Werner in a study of thirty-four eyes with nontreated primary glaucoma found one with an acute congestive attack and a partly closed angle and two with chronic congestive glaucoma and a partly closed angle (100 per cent). On the other hand, in twenty of twenty-eight eyes with simple glaucoma the angle was open (i. e., in 71 per cent) while in eight (26 per cent) synechia was present. In a study of sixty treated glaucomatous eyes he found five with acute glaucoma; in

two (40 per cent) the angle was closed, and in three (60 per cent) partly closed. Of forty-nine eyes with simple glaucoma thirty-nine (79 per cent) had the angle open.

Although Werner's percentage in cases of congestive glaucoma with closed angle are higher than mine, in studies of simple glaucoma all observers found that in the majority of cases the angle is entirely open. I do not agree with Werner in his assertion that peripheral synechia could not develop or increase in the course of simple glaucoma. I have reported seven cases (histories of cases 3 to 7 have been omitted from this paper for the sake of brevity) in which the development and progress of peripheral synechia could be observed and recorded.

Peripheral Synechia and Height of Intra-Ocular Pressure.—The height of the ocular tension is not in correspondence with the extent and depth of the peripheral synechia. The angle may be found open with pressures varying from 25 to 50. Werner had the same results: In twenty-two cases of simple glaucoma with open angle the tension varied from 22 to 67.

There is no relation between the size and width of the peripheral synechia and the height of intra-ocular pressure. A high reading may be found with either trabecular or scleral synechia. The tension may change from 22 to 31 to 40 with unchanged total scleral synechia.

Size of Pupil and Its Bearing on the Angle.—Werner tabulated data on twelve eyes with congestive and twenty-two eyes with simple glaucoma showing that the size and shape of the pupil have no influence on the formation and depth of peripheral synechia. In a case which I observed, an oval, drawn up pupil did not correspond to a peripheral synechia upward.

Action of Miotics and Mydriatics.—This was studied by Werner. Mydriatics may narrow the angle in normal eyes but do not close it entirely. I have seen miotics detach synechiae at the beginning in some cases, but not in others. The sinus may remain occluded even when miotics have brought down the tension.

Condition of the Angle After Operations.—Before the advent of gonioscopy surgeons had to guess about the results of their operations in the structures concealed by the limbus. Sometimes entirely unexpected complications were found in the living eye. The theory and ways of action of the different operations appear in a totally different light.

Iridectomy.—The most common explanation of the action of iridectomy in glaucoma was that it worked by reopening the angle of the anterior chamber closed by hypertension; that detachment of the peripheral synechia reestablished the outflow, but that when this did not occur on account of the synechia being permanent the effect was nil. These

statements had no support in facts. Nobody had seen whether the normal outlets were reestablished when the operation was successful and vice versa. Since publication of my first paper [22] I have pointed out that the reopening of the angle is not a necessary condition for the success of iridectomy. I described four cases in which the tension came down after iridectomy even when annular corneal synechia existed before and persisted unchanged after the operation. No filtering scar existed. In other eyes, however, in which iridectomy had been done earlier and the synechia was only mechanically applied, the operation succeeded in detaching the synechia, at least in part. Mention has been made of five cases of this type. In some of them, no further advance of the synechia was observed.

In four cases of simple glaucoma with an entirely open angle in which iridectomy was performed, the tension came down and the angle remained open. Werner's observations confirm these facts.

I conclude: 1. The reopening of a closed angle is not necessary for the success of an iridectomy in acute glaucoma. 2. This operation succeeds in lowering the tension and in many cases improves the vision even when the angle remains totally closed. 3. The detachment of the peripheral synechia from the cornea, although beneficial to the nutrition and function of the eye, is not a condition sine qua non for the reestablishment of the outflow even when a nonfiltering scar is present. 4. In eyes affected with simple glaucoma and with the angle open, iridectomy may be successful in lowering a high tension although no change has been brought about in the condition of the angle. 5. Although peripheral synechia is not the cause of glaucoma, its presence means an added difficulty for the outflow of liquids from the eye.

I believe that iridectomy acts in acute glaucoma mainly by reestablishing communication between the anterior and the posterior segment of the eye. There is undoubtedly an increase of pressure in the vitreous by accumulation of liquids, as proved by the shallow anterior chamber in the eye with acute glaucoma. The outflow is rendered still more difficult by the swelling of the vitreous ring filling the perilental space and by the valvelike action of the iris, which becomes tightly applied to the capsule of the lens by the conflict of the posterior and anterior pressures.

Iridectomy works (1) by providing a large aperture between the chambers through which liquids circulate better and the pressures on both sides are equalized; (2) in some cases by detaching peripheral synechiae and thus reopening the normal outlets; (3) by relieving the pressure on the veins of the iris and ciliary processes and permitting a larger absorption of aqueous, this effect being greater when the synechiae are detached.

It is better, therefore, to make large complete iridectomies which will include the sphincter downward and the root of the iris upward. However, in a great number of iridectomies a strip of the root of the iris remains above the coloboma without impairing in the least the success of the operation. There is no reason for trying to tear out the root of the iris by dialysis when gonioscopy has shown that the angle is open at that place. Besides the well known indication for iridectomy in acute and chronic glaucoma there is indication for its use in the simple type when the angle, originally open, starts to close owing to minimum congestive attacks.

The Mechanical Conception of the Therapy for Glaucoma.—The success of an operation should not be measured in terms of lowered ocular tension alone, but also by its effects on vision, visual field and advancing excavation. There is need to react against the idea that the treatment of glaucoma is simply a mechanical problem, a question of hydrodynamics. Many surgeons perform one operation after another without giving the fine compensatory mechanisms which regulate intra-ocular pressure time to adapt the eye to new conditions.

Fistulization.—This method is based on the assumption that the normal outlets of the anterior chamber are so hopelessly damaged and occluded that a new permanent way of excretion has to be devised. It is peculiar, however, that trephining has been recommended mainly in cases of simple glaucoma, in the majority of which gonioscopic findings have shown that the angle is entirely open. Thus the so-called "permanent drainage" has been added to an open angle even when tension was not permanently high. An overfilled reservoir is tapped, hoping that a spigot (the episcleral tissues) may take care of the overflow and regulate it in such a way that the intra-ocular pressure may remain about normal. Although there are many cases in which this equilibrium is obtained, in the majority either the hole closes and the tension goes up again or it remains widely open and then the eye becomes permanently hypotonic. A free fistula is a great menace to the eye, not only because of the danger of infection (iritis, late infection), but also because a hypotonic eye slowly degenerates and vision declines. There are also some mechanical complications, such as incarceration of the ciliary processes or of the iris itself and occlusion by exudates, which have been observed with the gonioscope in living eyes.[2d] Werner also reported finding the last two complications often, and he emphasized the fact that in cases of simple glaucoma, when the angle was partially or totally open, trephining produced a more or less complete closing of the sinus. In my opinion, this operation should be confined to cases in which the gonioscope shows that the angle is entirely closed or in which iridectomy has failed. Operations in cases of glaucoma are

intended only for abatement of the hypertension, and they probably have no action on the primitive cause of glaucoma.

Iridencleisis.—According to Werner, the incarceration takes place in the Schlemm band itself or in front of it and, exceptionally, far backward. In a study of ten eyes with simple glaucoma and an open angle before the operation, the angle was found entirely closed after it in six cases, and in two others a synechia progressed from partial to corneal.

Studies on cyclodialysis and other decompressive operations will be reported in a following paper.

CORNEAL ULCERS DUE TO A COMMON ALLERGEN

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The surface tissues, namely, the skin and the mucous membranes, constitute the principal sites of the allergic reaction. The symptoms vary according to whether the allergen is inhaled, ingested or brought into immediate contact with the tissues. The eye with its coverings of skin and mucous membrane and richly endowed with an abundant blood and nerve supply is often the site of such a reaction. The present study of the etiology of corneal ulcers offers further evidence of a growing interest in the allergic aspect of cases seen by the practicing ophthalmologist. In a recent editorial in one of the journals on ophthalmology [1] the statement was made, "It is not to be denied that many inflammations of the conjunctiva are manifestations of allergy and will yield most readily to treatment based upon the recognition of this fact." Lehrfeld,[2] in reporting his observations on eighty-seven cases of vernal conjunctivitis, stated that this condition is an ocular manifestation of allergy. Experience with a number of such cases leads me to the same conclusion. I believe that most, if not all, allergists are of the same opinion. Blanco [3] wrote about two cases of vernal catarrh complicated by corneal ulcers. Of great significance were his notations that the corneal change was an epithelial degeneration leading to a pulverulent desquamation, and that an eosinophilia was present in the tissues. Beigelman [4] also concluded that corneal involvement must be considered a frequent complication of vernal catarrh. Another interesting report was made by Tooker.[5] He observed that the ingestion of certain foods caused an exacerbation of symptoms in cases of tuberculous keratitis, and therefore he recommended that a thorough allergic study be made of each patient.

The conjunctiva, whether palpebral, fornical or bulbar, is a very thin epithelial structure, the first and third sections being closely adherent to the underlying tissues. The conjunctivae have a rich blood and nerve supply. The cornea is made up of several distinct layers, of which the

1. Editorial, Am. J. Ophth. **14**:356, 1931.
2. Lehrfeld, Louis: Vernal Conjunctivitis, Arch. Ophth. **8**:380 (Sept.) 1932.
3. Blanco, Tomas: Corneal Complications of Vernal Catarrh, Arch. de oftal. hispano-am. **31**:25, 1931.
4. Beigelman, M. N.: Dystrophy of the Corneal Epithelium in Vernal Catarrh, Am. J. Ophth. **15**:95 (Feb.) 1932.
5. Tooker, C. W.: Allergic Phenomena in Tuberculous Keratitis: Report of Two Cases, Arch. Ophth. **2**:540 (Nov.) 1929.

epithelial layer is the most important in the present study. Normally, it has no blood vessels, its nutrition being provided by a system of lymph spaces. The absorption of an allergen, whether by the eye directly or through inhalation or ingestion, causes a rapid distention of conjunctival blood vessels with edema of the ocular as well as the palpebral conjunctivae. Lacrimation and severe itching also occur.

The ocular symptoms accompanying seasonal hay fever and asthma are well known and easily recognized. However, in many instances a great many variations in the degree of reaction of the eye to the allergen are encountered. Some patients may experience only slight itching of the eyes but pronounced nasal and bronchial disorders. In other patients, the redness and itching of the eyes may be marked while the minor nasal symptoms may be overlooked. Difficulties in diagnosis may be met in perennial disturbances of the eye if the ocular symptoms are so light and so intermittent as to be disregarded entirely by the patient or overlooked by the medical examiner in taking a history. Allergy should be considered when chronic conjunctivitis, blepharitis and eczema of the lids have proved refractory to the usual treatments. The exciting agent may not be so apparent as the dye in eyelash preparations such as "Lashlure," which has produced disastrous reactions in the eye, but the painstaking cooperation of an allergist will often reveal the offending allergens.

Corneal ulcers are primary when the lesions start in the cornea and secondary when they have extended from adjacent structures, most frequently the conjunctiva. In the following case, the ulcers may have resulted from the chronic conjunctivitis. They may also have occurred as a primary reaction to the allergen, due to the edema and desquamation of the corneal epithelium. Analogous lesions are formed in the nasal mucosa in hay fever, aphthous lesions of the buccal mucosa on the ingestion of an offending food, etc. Thereafter, it is an easy matter for bacteria to invade the tissues and produce an infection which later may actually overshadow the original pathologic process.

REPORT OF A CASE

Sister M. R., a nun aged 36, teacher in an academy for young ladies, was referred on April 13, 1933, by Dr. Joseph J. Zimmermann, a local ophthalmologist, who requested that a search be made for the underlying cause of the corneal ulcers in her right eye.

History.—Since 1926 she had noted "spells" during which there were lacrimation, itching and "little gatherings" on the lids of both eyes. Often these symptoms were accompanied by sneezing and watery discharge from the nose. The first ulcer appeared in the right eye in 1931. The usual pain, photophobia and lacrimation accompanied the onset of the ulcer. The itching also was pronounced. These syndromes, relieved by sedatives, recurred at irregular intervals. Within a short time, a second ulcer appeared on the same cornea. The lids became red and swollen.

The early childhood of the patient was uneventful. For the past thirteen years she had had hives accompanied by bloating and gastric distress. Two abscessed teeth were removed in 1930, one year before the onset of the ulcers.

The family history was negative for allergy and tuberculosis.

Examination.—Physical examination revealed two small ulcers in the right cornea involving the corneal substance. There was considerable vascularization of the entire cornea. The upper and lower lids of both eyes showed marked redness and hyperplastic changes in the conjunctivae. The margins of the lids, also red and thickened, were studded with small pustules. The nasal mucosa was somewhat thickened and covered with an excess of watery secretion. The sinuses were normal. The teeth, tonsils and rest of the body were free from focal infection. Dermatographia was noted. The usual laboratory tests were all negative.

A full set of diagnostic skin tests was made. A marked reaction to orris root occurred. Positive reactions were also obtained to silk, peas, lettuce, sweet potato, cheese, staphylococci and streptococci. When orris root powder was placed in the left eye, the palpebral conjunctiva quickly became red, the blood vessels dilated, and the cornea and the rest of the bulbar conjunctiva turned red and edematous. Itching and lacrimation also were noted. In view of the fact that dionin and atropine sulphate solutions had been used to relieve her from the symptoms, scratch tests were made with them. The atropine gave no reaction, but the dionin reacted positively as did also the control. This is not surprising since most people, non-allergic as well as allergic, give a positive reaction to this alkaloid.

Contact with orris root was traced not only to the cosmetics which her pupils used but to the sachets which were used as a deodorant for the silken church vestments. It was her duty every day to arrange and put away these vestments at the end of the church services.

Treatment and Course.—The treatment was simple and effective. Her duties were changed so as to avoid the sachets and other orris root preparations. A suitable eliminative diet was prescribed. Hyposensitization by subcutaneous injections of orris root extract was carried out because it was impossible for her to be completely free from all contact with this substance. Later, a combined vaccine of staphylococci and streptococci was administered. The use of dionin was stopped while that of atropine was continued for a short time.

Within several months the lesions healed completely. In his follow-up, Dr. Zimmermann noted gradual diminution in the density of the corneal scars. For nearly two years the patient has experienced no recurrences.

COMMENT

This patient is definitely allergic. There is a history of many years of hives, accompanied often by gastric symptoms. There were years of ocular symptoms associated with "spells" of sneezing and rhinorrhea. In spite of local eye treatments and the extraction of diseased teeth, the ocular symptoms continued, and two ulcers formed on the right cornea. Positive skin and ophthalmic reactions to orris root, to which she was daily exposed, and the subsequent improvement on administration of hyposensitizing doses of orris root extract give additional evidence of the allergic make-up.

The question whether the corneal ulcers were caused primarily by the reaction to orris root or secondarily by the chronic conjunctivitis

is only one of didactics. In favor of the former view, one may point to the direct eye test with orris root in which the cornea became edematous and injected. A constitutional reaction following parenteral administration of an overdose of an allergen usually includes a marked edema of the conjunctivae in its symptomatology. This edema plus the accompanying severe itching and rubbing of the eye causes a break in the corneal epithelium. The ulceration may have resulted secondarily from the chronic conjunctivitis which occurred as a result of the repeated reactions to the powdered orris root. Just as prolonged action of atopens on the nasal mucous membrane permits an easy invasion by bacteria and even polyp formation,[6] the same process in the conjunctiva allows a facile implantation of bacteria.

After some time, the conjunctiva becomes reddened, thickened and roughened in outline. Add to this the considerable rubbing of the lids, and the element of trauma is introduced. As soon as the ulcer is formed, dionin and atropine are prescribed. It is quite possible that the former is contraindicated because dionin, as well as other opium derivatives, causes redness and edema when applied to any abrasion of the surface tissues. I have been informed that today dionin is not used as often as it formerly was.

SUMMARY

1. A case of corneal ulcers is reported the cause of which was traced to a hypersensitiveness to orris root.

2. Specific treatments were given, and for the past two years there has been no recurrence of the ulcers. The accompanying disease of the lids and the rest of the conjunctiva has disappeared.

3. Evidence is submitted to show that dionin is contraindicated in the palliative treatment of corneal ulcers.

4. It is believed that an allergic study of other cases of corneal ulcers will elicit the basic etiologic factors and thus increase the percentage of successful treatments.

5. The timely recognition of hypersensitiveness in many cases of chronic conjunctivitis in which the condition proves refractory to the usual forms of treatment may help to prevent the formation of corneal ulcers and the subsequent impairment of vision.

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DILATED AND TORTUOUS RETINAL VESSELS

REPORT OF A CASE OF CONGENITAL ARTERIOVENOUS COMMUNICATION

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Congenital arteriovenous communication in the retina is very rare, only about nine cases having been reported in the literature. The presentation of another case is therefore deemed of sufficient interest for publication.

REPORT OF CASE

A woman aged 32, married, had no symptoms referable to the eyes. Vision in each eye was 20/20 plus. The usual examination disclosed nothing abnormal in the left eye. There were no abnormalities of the cornea, lens or anterior or posterior chamber of the right eye, but on looking at the fundus one was immediately struck by the enormous size of the arteries and veins, fully five or six times the average size of normal vessels. Outside the disk it was difficult to differentiate between the arteries and the veins, either by color or by size. The superior nasal and temporal vessels, while greatly dilated, were fairly straight, so that their course could be followed from the disk to the periphery. The inferior vessels, however were entangled like the proverbial caput Medusae, so that it was possible only with difficulty to follow any vessel through its entire course, either from or toward the disk. Along the vessels were small patches of pigmentation (fig. 1).

After prolonged search, we found in the lower portion of the periphery an arteriovenous communication so isolated from the other vessels that the diagnosis was definitely established. One other place seemed to show arteriovenous communications, but we could not be sure, because the small artery passed behind a thick vein and may not actually have formed a communication. Examination of the fields with small white and colored test objects, both on the perimeter and on the screen, revealed no defect. Several members of the patient's family were examined, but no ocular abnormalities were found.

COMMENT

Angiomatosis retinae (von Hippel's disease), the first condition suggested by the picture of the fundus, was ruled out because we could find no characteristic "bee's-nest," although telangiectases may be situated in the extreme periphery, making it impossible to demonstrate their presence. However, the preservation of excellent ocular function in a person of the age of this patient would be most unusual in a case of angiomatosis retinae, and the communication of an artery and a vein was clearly seen.

The striking feature of this fundus is the loss of distinctive character of both the arteries and the veins, associated, however, with normal vision. The loss of character is the inevitable result of a short circuit by which arterial blood is pumped directly into a vein without the gradual reduction in pressure produced by a great increase in the cross-section of the circulatory bed and by an even greater increase in friction against the walls of much narrowed vessels. Long before

Fig. 1.—Retinal vessels of a woman of 34 with normal vision. The condition was discovered during a routine examination. The vessel indicated by the arrow in the upper left portion of the field is an artery that curves down and in to reappear in the picture at the point designated by the arrow below, from which the communicating vessel passes over to the vein.

the blood has reached the smallest veins pulsation is lost, and the current is tranquil.

Veins cannot withstand the intermittent direct pressure exerted by the heart and the constant tonus of the elastic-walled arteries, and when a short circuit develops they immediately dilate, lose some of the normal dark color and become tortuous and twisted. It is not unusual

in cases of acquired lesions of this type to find a vein enlarged to five or six times its normal size. The artery also enlarges; it becomes darker and is so curved and twisted that it is often impossible to tell which is artery and which is vein without tracing the vessel back to the disk to see from which type of vascular stalk it comes. This anomaly is incompatible with good vision unless the condition is congenital. In the cases in which examination was made and in all the reports of cases which were read, not even fair vision was afforded, to say nothing of that indicated by the reading 20/20. A few congenital arteriovenous communications of the retinal vessels associated with similar anomalies in the orbit have been reported, and in these cases, too, central vision was lost.

The cases of congenital short circuit reported are not numerous, and the conditions are of three types: arteriovenous, intervenous and interarterial. There is little or no change in the arteries of an eye with communicating veins, and the veins are not concerned in the few cases of artery-to-artery communication. The vision is also unchanged in either group. In a few cases on record a greatly enlarged vein runs out from the disk to become lost finally by dipping into a defect in the choroid, in which it is assumed that the vein connects with the choroidal circulation. These conditions are congenital, and neither the vision nor the arteries are concerned. The types of acquired communications include one outstanding condition, angiomatosis retinae or von Hippel's disease. A few cases of arteriovenous communication after injury have been reported, but in the few instances of pronounced defect the diagnosis has been questioned, as many authors expressed the opinion that the anomalies were congenital and the injury was accepted as the cause of poor vision, but as otherwise without influence. The cases have been few, because an injury serious enough to produce poor vision is liable to cause cataractous changes which would prevent examination of the fundus.

Several cases of blocking of an artery or vein have been observed in which a new vessel from an adjoining artery or vein, respectively, developed to reestablish circulation in the injured branch beyond the lesion. The vessel in no instance was large; veins were involved more often than arteries, and the vessels of the fundus retained their true character (fig. 2).

Formation of new vessels after vascular accidents near the disk is rather common, and the character of these vessels is plain and need cause no confusion with the anomaly we have in mind.

Angiomatosis retinae is what the name indicates, but its clinical features are two: loss of character of larger individual arteries and veins and the presence of nevi in the retina. These nevi are often called "bee's-nests," although some of them resemble a red, lobulated berry.

The nevus that provides the short cut from artery to vein may not be visible at all; it may be too far forward to be seen, or it may be hidden away under the detached retina or covered by exudate. The vision fails as soon as the stalks of some of the main vessels are involved; in fact, loss of vision is the common reason that the patients call for attention. In not a few of these cases the condition was bilateral; in several the defect was found in a parent and a child, and the anomaly is probably the result of a congenital error in which the lesion does not enlarge sufficiently to damage the retina until the patient is in the teens or early twenties. As is embryologically reasonable, similar nevi have been observed in the brain and especially in the cerebellum, in which case

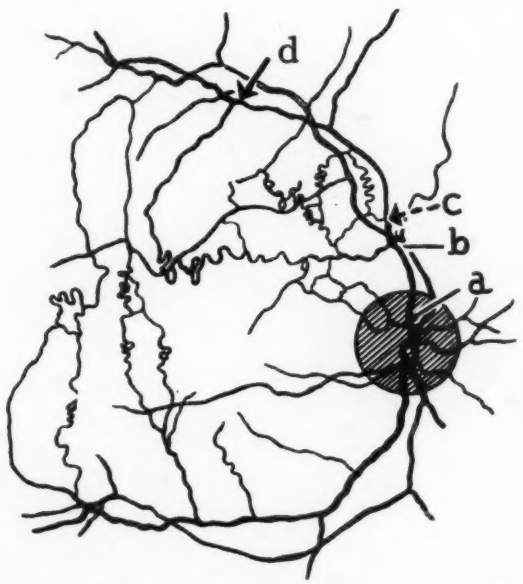

Fig. 2.—Venous communications established after vascular disease. The superior venous stalk was seriously diseased from *a* to *b* and almost closed from *c* to *d*. The communicating veins are said to be nature's way of repairing the damage. (Elchnig, A.: Klin. Monatsbl. f. Augenh. **36**:55, 1898.)

the characteristic lesion of angiomatosis is now known as Lindau's disease. The diagnosis of the condition in about half the cases has been made by the pathologist after enucleation of the eye for the relief of pain in cases of absolute glaucoma. In the other half of the cases the diagnosis has been made early in life, and the process has subsequently been observed until blindness and then glaucoma developed and enucleation eventually was necessary. Extensive facial nevi are often associated with much dilated retinal vessels or with angioma of the choroid. The eye may show an increase of tension immediately after birth, and the condition may become typical buphthalmos, or the

development of glaucoma may be postponed for several years. Tortuous, twisted and dilated vessels may be observed in the brain itself or in the meninges. This is not to be wondered at, and is in keeping with the observations made in cases of Lindau's disease. The enlarged retinal vessels are sometimes so extensive that the mass formed can be truthfully called cirsoid. In the typical cases implication of the brain is indicated by homonymous hemianopia, and a roentgenogram may show the twisted and tortuous vessels running far back into the occipital lobe on the involved side.

The early ophthalmoscopists were much concerned over cases in which the eyes revealed normal vision, greatly dilated veins and arteries

Fig. 3.—Dilated vessels in a case of von Hippel's disease. The arrow points to a quiescent nevus. The short circuit causing the dilatation of the vessels is so far forward that it cannot be seen with the ophthalmoscope.

and no error in refraction other than varying degrees of hyperopia. Both eyes were usually involved, but several cases in which one eye was normal and the other showed tortuous vessels have been reported. Hyperopia was recognized as a state of underdevelopment of the eye, but no one has yet explained this odd vascular condition so frequently seen that it no longer attracts special notice. Pulsating exophthalmos is sometimes characterized by tortuous retinal arteries and veins, but there is no communication between vessels in the retina. This anomaly is not well tolerated, for there often develops a central scotoma that ruins vision for details. Even if the condition is improved by ligation

of the carotid artery, vision does not return. The fundus appears as though covered with "peach-bloom," and despite relief from the subjective annoyances after ligation, it may appear no different after the operation than before. Dr. J. N. Evans demonstrated the intimate relation between the size of the blindspot and retinal congestion in cases of pulsating exophthalmos. He mapped the blindspot of both eyes of a woman suffering from pulsating exophthalmos of the left eye. The blindspot of the uninvolved eye was normal in size, but that of the left eye was much enlarged. Pressure applied for a few minutes to the carotid artery in the neck on the side of the defect reduced the blindspot almost to the normal size, but it immediately returned to the original status. There was a moderate decrease in the size of the blind-

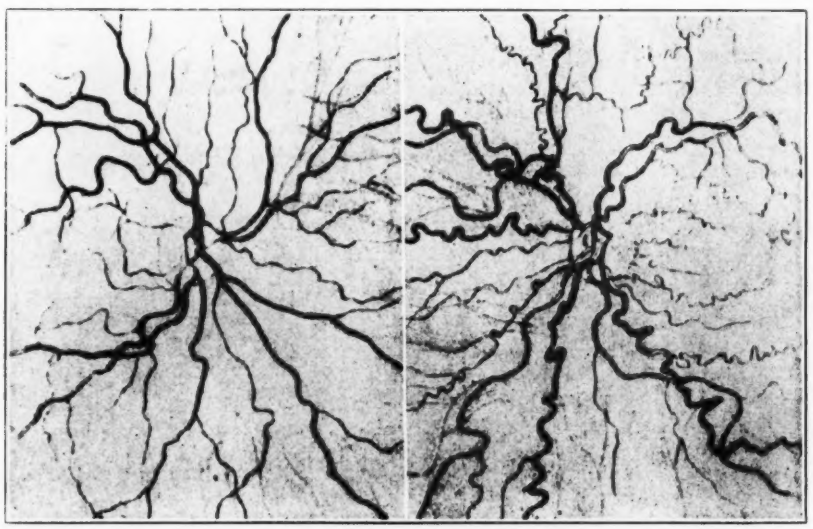

Fig. 4.—Retinal vessels in a case of hyperopia observed by Mackenzie (Tr. Ophth. Soc. U. Kingdom 4:152, 1884). The right eye gave the better vision.

spot after operation, as compared with that noted before, which relieved all the annoying symptoms. One is inclined to assume that the central scotoma is the result of enlarged vessels in the optic nerve trunk behind the eye, but there is a possibility that pressure of dilated vessels on the nerve near the chiasm or even in the optic canal might be the real cause.

Newly formed blood vessels after retinal hemorrhage in elderly persons or in patients with diabetes are sometimes extensive, but this type should not be confused with either the congenital or the acquired variety of communicating vessels or with the dilated vessels in the other conditions included in this paper, because of the associated pathologic picture and its evident connection therewith.

Cyanosis retinae is another condition of similar nature, with greatly dilated arteries and veins, the result of congenital cardiac lesions inducing marked venous stasis. Even the vessels of the conjunctiva and episcleral tissues and those of the ciliary region may be greatly distended, as are those of the retina. Cases of this disease are indeed rare but are so typical that no error in diagnosis should occur.

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CIRCULATION OF THE AQUEOUS

IV. REABSORPTION OF COLLOIDS

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In a previous article [1] the rôle of the blood vessels of the iris in the absorption of foreign and native crystalloids from the anterior chamber has been discussed. The experiments there presented led to the conclusion that the fate of foreign crystalloids injected into the anterior chamber bore no relation to the rate or mechanism of reabsorption of water, the former being controlled by the rate of diffusion of the crystalloid and the area of the vessels of the iris exposed to this diffusion, while the latter depends on hydrostatic and colloid osmotic pressure differences between the aqueous and the intravascular fluid, particularly the fluid within Schlemm's canal. It was a natural extension of this study to investigate by the same technic the absorption of colloids from the anterior chamber.

This investigation was undertaken initially with a view to discovering whether there are any open channels through which fluid may leak out of the anterior chamber, either directly into Schlemm's canal or into the perivascular spaces about the perforating vessels of the limbus. It was believed that since colloids cannot freely diffuse across an endothelial membrane the rate of disappearance of the colloid from the anterior chamber might furnish an index of the rate at which fluid was escaping by such open channels if, in fact, any did exist. So far as the solution of this particular problem is concerned, the work was a complete failure, for the rate of disappearance of the colloids was found to be so rapid that inconceivably rapid rates of water flow would be required to account for their removal, if they were merely being washed out in the mechanical way suggested. For instance, from 30 to 80 per cent of the injected colloid may disappear in the first half hour. If this were accomplished wholly by water transport it would indicate a rate of leakage of the aqueous such that the whole volume of fluid in the anterior chamber would need to be replenished every twenty to

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1. Friedenwald, J. S., and Pierce, H. F.: Circulation of the Aqueous: III. Reabsorption of Crystalloids, Arch. Ophth. **10**:449 (Oct.) 1933.

sixty minutes. Some mechanism other than simple water transport must evidently be concerned in this rapid cleansing of the anterior chamber of colloidal material.

The location of this mechanism was readily apparent. Even a cursory inspection of the ocular tissues removed a short time after the injection of a colloidal dye into the anterior chamber reveals immediately that the iris is heavily stained with the dye, and by more indirect methods the absorption of colorless colloids into the iris can be equally well demonstrated.

There are few experiments in ophthalmology that are easier to perform than the injection of some foreign solution into the anterior chamber of an experimental animal, and few experiments have been done more frequently. The number of publications based on such experiments is so great that a complete review of the literature would require far more space than the subject merits. In brief synopsis it may be said that the work in this category falls into four major divisions:

A. Those investigations which make up the prolonged polemic between Schwalbe and Leber and their followers on the permeability of the walls of Schlemm's canal,[2] in which it was finally shown that colloids of small size readily pass from the anterior chamber into the canal, while large colloidal particles are, in the main, held back at this barrier, though occasionally large colloidal particles and even microscopically visible particles may enter the lumen of the canal, as it were, by diapedesis.

B. Investigations concerned with the demonstration of currents of fluid in the eye. Of these the work of Nuel and Benoit,[3] among the earlier workers, and that of Takahashi,[4] among the more recent, are the most important. It will be shown in this paper that the disposition of colloids or even of particulate matter in the ocular tissues after intra-ocular injection can be taken only with grave reservations as casting any light on the circulation of fluid within the eye.

C. Investigations in which the rate of disappearance of some injected substance is measured as an index of the rate of circulation of intra-ocular fluid. Among these the studies of Knies[5] on the reabsorption

2. Leber: Die Cirkulations- und Ernährungsverhältnisse des Auges, in Graefe, T., and Saemisch, E. T.: Handbuch der gesamten Augenheilkunde, ed. 2, Leipzig, Wilhelm Engelmann, 1901, vol. 2, pt. 2, p. 276 and footnotes.

3. Nuel, J. P., and Benoit, O. F.: Ophth. Rev. **17**:232, 1898; Tr. Internat. Cong. Ophth. **9**:75, 1899; Arch. d'opht. **20**:161, 1900.

4. Takahashi, H.: Arch. f. Ophth. **115**:305, 1924-1925.

5. Knies, M.: Virchows Arch. f. path. Anat. **62**:537, 1874-1875; Arch. f. Augenh. **7**:320, 1878.

of blood and of Wessely [6] on the reabsorption of serum proteins are of special interest. Since the mechanism of absorption of colloids and particulate matter from the anterior chamber is entirely distinct from that of the absorption of water, the conclusions of these investigators are in error, but the velocity of absorption of colloid which they found is of interest and is in general agreement with the results to be reported here.

D. Finally, a group of studies directed toward an understanding of the reticulo-endothelial system of the eye, the cellular reactions produced by the injection of foreign colloids into the eye and the final mode of disposition of this material within the reacting tissues.[7]

In view of the vast array of the work already published, some temerity is required to add another item on this subject, but the results of the experiments to be reported throw some new light on the matter and resolve some of the older problems. This study consists of two parts: (1) the determination of the rate of disappearance of a variety of colloidal substances injected into the anterior chamber and (2) the histologic study of the locus of their primary deposit in the ocular tissues and of their subsequent disposition.

RATE OF DISAPPEARANCE FROM THE ANTERIOR CHAMBER

Several substances (vital red, congo red, gentian violet, hemoglobin, serum proteins and vitreous mucoid) were injected into the anterior chamber of dogs' eyes, and the rate of their disappearance was measured. The experiments were performed precisely according to the technic previously described in the study of the reabsorption of crystalloids from the anterior chamber. Under morphine and barbital sodium anesthesia the anterior chamber was filled, at normal intra-ocular pressure, with a solution of known concentration of the test substance. After the lapse of a variable period 0.2 cc. of the fluid in the anterior chamber was withdrawn for analysis. The concentrations of vital red and of congo red were determined in a colorimeter in alkaline solution. Those of gentian violet were similarly determined in neutral solution. Hemoglobin was obtained from the animals' own blood as follows: The cells were first washed free from serum by repeated centrifugation in physiologic solution of sodium chloride and then laked with ether and recentrifugated. The clear solution so obtained was carefully pipetted

6. Wessely, K.: Arch. f. exper. Path. u. Pharmakol. **39**:417, 1903.

7. Castello, B.: Ann. di ottal. e clin. ocul. **55**:607, 1927. Barletta, V.: ibid. **55**:941, 1927. Farina, F.: ibid. **56**:440, 1928. Stilo, A.: ibid. **59**:566, 1931. Kikai, K.: Arch. f. Augenh. **103**:541, 1930. Marx, E.: Arch. f. Ophth. **114**:465, 1924; **116**:114, 1925. Knüsel, O., and Vonwiller, P.: Ztschr. f. Augenh. **49**:157, 1922; **50**:23, 1923; **51**:257, 1923; **53**:61 and 191, 1924. Schnaudigel, O.: Arch. f. Ophth. **86**:93, 1913.

off, and the ether was then removed by evaporation in a vacuum. The concentration of hemoglobin was determined colorimetrically as hematin by the method of Cohen and Smith.[8] It was found that by using a green glass in the eyepiece of the colorimeter the accuracy of the readings could be much enhanced, and duplicate samples were found to agree within 0.5 per cent, provided that due care was used to avoid aging of the standard solution used for reference.

In one series of experiments the concentration of serum proteins was determined by refractometric readings. Subsequently this admittedly imperfect method was checked by separate determination of the total protein and of the albumin fraction with a modification of Greenberg's[9] procedure. These two methods yielded substantial agreement in regard to the rate of absorption of serum proteins, but the second method revealed an irregular and at times marked relative increase of albumin plus nonprotein nitrogen at the expense of globulin. It was found that a similar disappearance of globulin occurred when blood serum was incubated with freshly withdrawn aqueous, indicating that the aqueous at times contains enzymes capable of digesting globulin and also albumin.

The vitreous mucoid was obtained by filtration of the crushed vitreous of cows' eyes. Since quantitative chemical measurements are out of the question in small volumes of this material, it was decided to use some physical method of measurement. The outstanding physical property of the vitreous filtrate is its viscosity. In some preliminary experiments it was found that the depression of fluidity (the reciprocal of viscosity) was very nearly a linear function of the concentration of the filtrate. Furthermore, it was found that both the depression of the fluidity and the increase in the refractive index of solutions containing mixtures of vitreous filtrate and blood serum were very nearly linear functions of the separate concentrations of these two substances. By measuring both the fluidity and the refractive index of a sample it was, therefore, possible to calculate with reasonable accuracy the concentration of the viscous element of the vitreous filtrate in the sample.

The results of these experiments are shown in the charts. It will be seen that the rate of disappearance of all these substances from the anterior chamber is extremely rapid, from 30 to 80 per cent of the injected substance being removed in the first half hour. The mechanism of removal, however, appears to be complex. With none of the substances studied does the rate of removal depend solely on the concentration present in the anterior chamber, as it should if the removal were simply dependent on diffusion outward of the colloid, and as was previously found to be the case with crystalloids.

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8. Cohen, B., and Smith, A. H.: J. Biol. Chem. **39**:489, 1919.
9. Greenberg, D. M.: J. Biol. Chem. **82**:545, 1929.

The removal of vital red from the anterior chamber follows a definite rule (fig. 1). Over a considerable range of concentration the amount of the dye absorbed per minute is constant, independent of the concentration. One can hardly escape the conclusion that throughout this range the absorbing surface is saturated with the dye, and that the constant rate of disappearance of the dye from the anterior chamber is dependent on some intrinsic mechanism of the absorbing surface. When a very low level of concentration is reached the curve becomes logarithmic.

The curve of absorption of the viscus element in vitreous filtrate (fig. 2) is similar to that of vital red, though we were unable to study

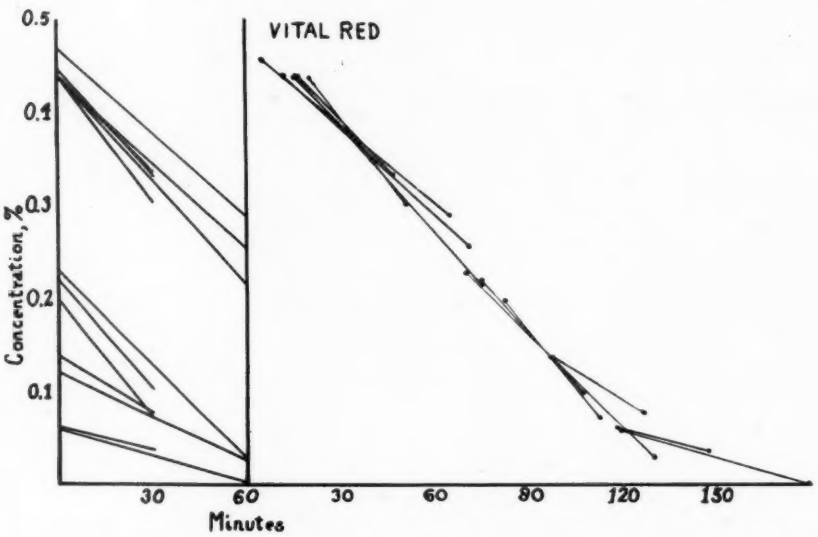

Fig. 1.—Absorption of vital red from the anterior chamber. On the left the results of each individual experiment are given. On the right these same results are grouped successively, showing that between concentrations of 0.5 and 0.1 per cent the amount of dye absorbed per minute is independent of the concentration.

the vitreous filtrate over as wide a range of concentrations as those applicable to the dye.

In contrast to these essentially linear absorptions, congo red (fig. 3) and gentian violet (fig. 4) showed rates of absorption that varied with the concentration present, but the percentage absorbed per minute decreased the longer the experiment was carried on, indicating a decreasing efficiency or fatigue of the absorbing mechanism. The rate of absorption of gentian violet was at all concentrations much higher than that of any of the other substances tested. It is to be remembered that gentian violet is a basic dye, and its colloidal particles therefore carry a positive charge. From this one would conclude that the absorb-

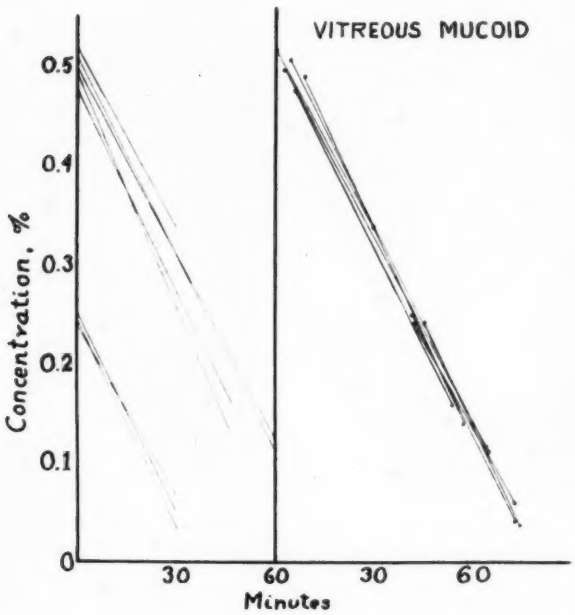

Fig. 2.—Absorption of the viscous element of the vitreous filtrate from the anterior chamber. The arrangement of the data is the same as in figure 1.

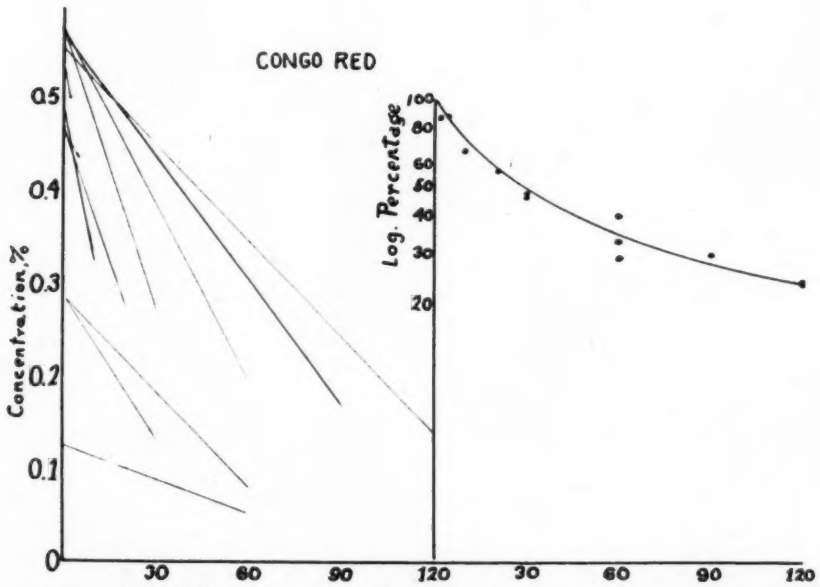

Fig. 3.—Absorption of congo red from the anterior chamber. On the left the results of each individual experiment are given. On the right the same data are plotted on a logarithmic scale in percentages of the initially injected material remaining in the eye after specified intervals of time.

ing surface carries a negative electric charge, as most living tissues do. Fischer [10] has made actual measurements of the electric charge of the surface of the iris and found that there is a negative electric potential on the surface of the iris with respect to the aqueous.

The rate of absorption of hemoglobin (fig. 5) follows approximately the simple logarithmic curve, but the results were so irregular that no definite conclusions could be drawn.

The concentration of serum proteins (fig. 6) falls very rapidly and approximately logarithmically during the first half hour after their injection. Subsequently, as the reactive hyperemia sets in, the rate of

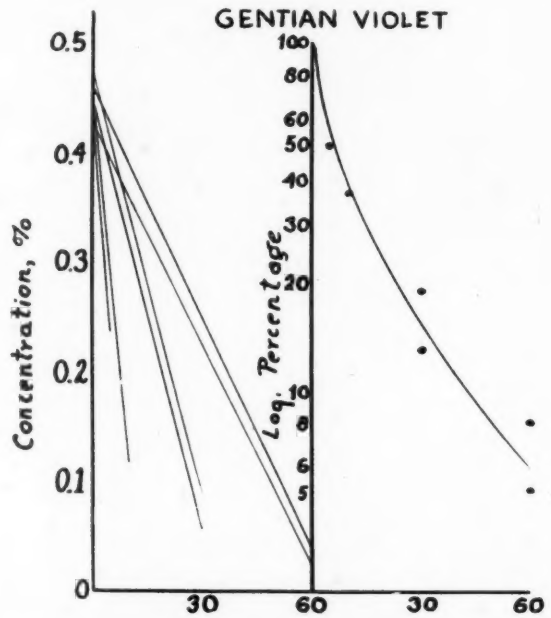

Fig. 4.—Absorption of gentian violet from the anterior chamber. The arrangement of the data is the same as in figure 3.

disappearance of proteins becomes much slower. The concentration of serum albumin follows much the same course. As has already been noted, the rate of disappearance of serum globulin from the aqueous proved to be very irregular, owing to the wide variations in the proteolytic activity of the aqueous (or of the surrounding tissues) in different experiments.

In summary, all the substances studied were removed from the anterior chamber with astonishing rapidity, in spite of the fact that, since they are colloidal, their rates of diffusion are necessarily very

10. Fischer, F. P.: Arch. f. Augenh. **106**:428, 1932.

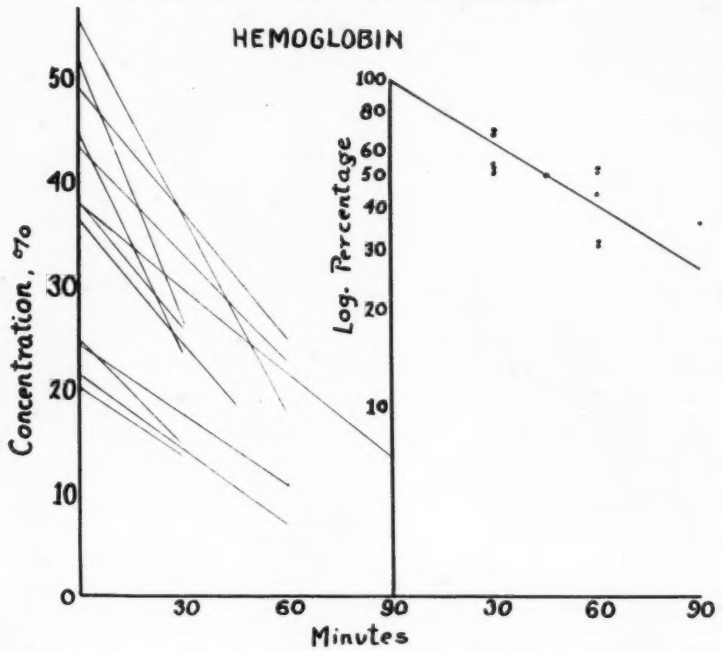

Fig. 5.—Absorption of hemoglobin from the anterior chamber. The concentration of hemoglobin is given in percentages as in the conventional readings of the hemoglobin content in whole blood. The arrangement of the data is the same as in figure 3.

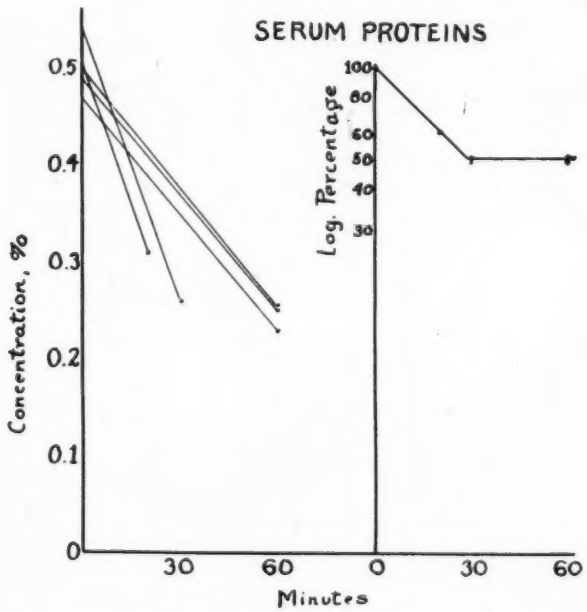

Fig. 6.—Absorption of serum proteins from the anterior chamber based on refractometric readings. The concentration is given in fractions of the protein concentration in the animals' blood serum at the beginning of the experiment. The arrangement of the data is the same as in figure 3.

slow. The rate of absorption follows no simple uniform law but varies not only in its magnitude but also in its dependence on time and concentration in different ways for different substances. These irregularities in behavior make it impossible to explain the disappearance of the injected material as depending on diffusion or on the circulation of water. On the contrary, these results clearly indicate that these substances are removed from the aqueous by absorption or adsorption into or onto the surrounding tissues. In the case of the colloidal dyes even cursory examination of the eye at the end of the experiments revealed that the major portion of the material had been absorbed by the iris. Indeed, it was this finding that induced us to repeat the experiments with colloidal solution less foreign to the tissues.

HISTOLOGIC STUDIES

Having found that the absorption of native colloids, or at least of colloids as nearly native as we could prepare them, was characterized by the same sort of discrepancies as that of foreign colloids, our next problem was to study histologically the disposal of the material adsorbed or absorbed by the iris. In addition to the material available from the experiments just reported, various solutions and suspensions were injected into the eyes of albino rabbits and the eyes were enucleated after periods of from one-half hour to several days. These injections included india ink, prussian blue, trypan blue, congo red and vital red.

In the eyes removed from one-half to one hour after the injection the injected dye was seen in greatest quantity within the endothelial-like cells which form the anterior surface layer of the iris. The colloidal material was not merely deposited on the surface of these cells but was actually within their cytoplasm. In this respect a sharp contrast is to be noted between the surface cells of the iris and Descemet's endothelium. Some particles of pigment were often present on the surface of Descemet's endothelium, but only rarely were there granules within these cells. It seems clear that the surface cells of the iris possess extraordinary powers of adsorbing and phagocytosing colloidal material with which they are brought in contact.

In the second hour following the injection of colloids into the anterior chamber monocytes begin to appear in the iris. It is impossible to tell whether these monocytes arrived there through the blood stream or whether they were proliferated in situ. No foci of proliferation or mitotic figures were noted in the sections. It seems certain, however, that some of the earliest monocytes seen in the tissues are merely cells of the surface layer which have taken on migratory activity. Figure 7 shows photomicrographs of the surface layer of the iris one-half hour

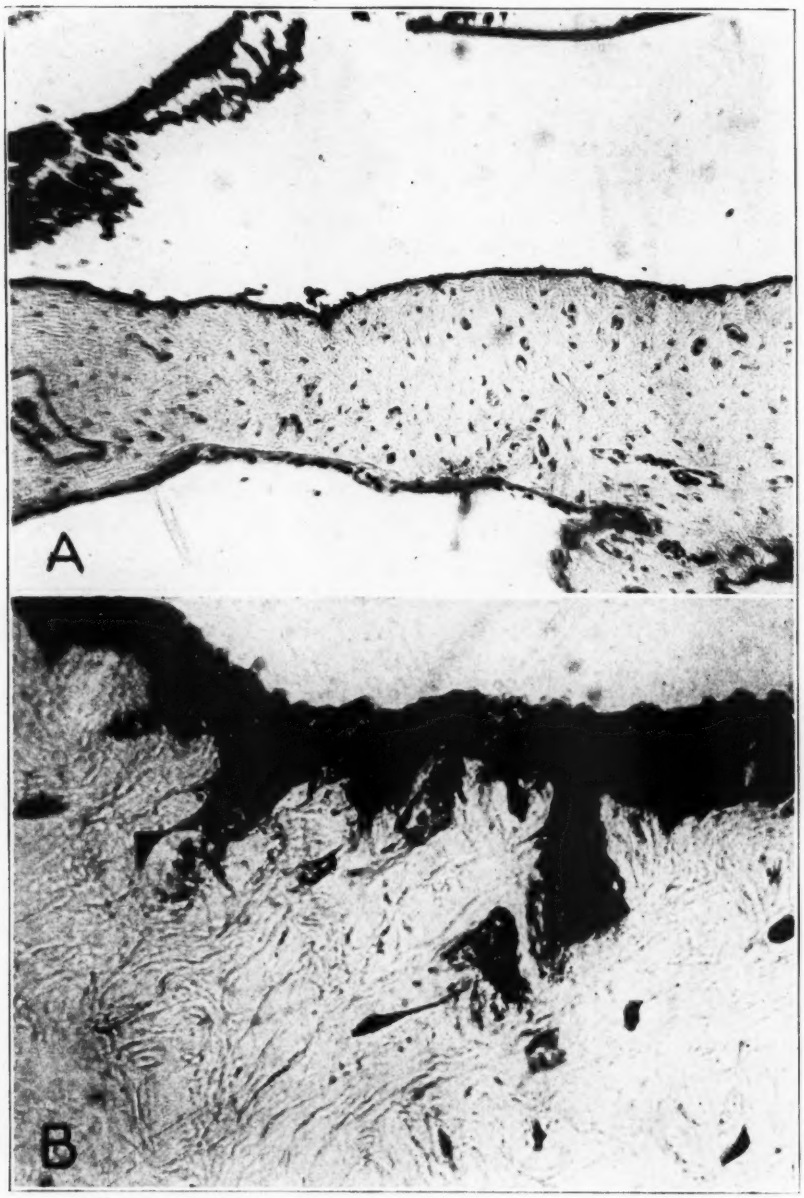

Fig. 7.—Photomicrographs showing india ink in the endothelium of the iris of an albino rabbit one-half hour after injection into the anterior chamber. *A*, with low power objective; *B*, with high power objective.

after the injection of india ink into the anterior chamber. Several of the cells which contain the heaviest load of ink granules have processes extending downward into the deeper layers of the iris as though they had begun to take on ameboid motion.

Whether the monocytes receive their load of pigment from the surface layer cells or are these cells themselves, they soon appear in the stroma of the iris in considerable numbers. Some make their way to the perivascular spaces within the iris, while others escape into the anterior chamber and are deposited on the posterior surface of the cornea and in the trabeculae of the pectinate ligament. Thence they make their way out of the eye by the perivascular spaces of the perforating vessels of the anterior part of the sclera.

The early deposit of particles of india ink on the surface of the iris was noted by Nuel and Benoit,[3] and these authors were led to believe from this observation that a considerable part of the intra-ocular fluid circulation escaped by this route. From the quantitative studies reported in the first half of this paper it is apparent that their conclusion was erroneous.

It was of interest to discover how far this absorptive activity of the surface layer of the iris was selective, and whether colloids less foreign to the body would be similarly dealt with. The quantitative results already reported would indicate that the mechanism of reabsorption of serum proteins and of vitreous mucoid would not likely be very different. Special methods are required to render such colorless materials histologically visible. In order to answer this question a colloidal solution of ferro-ferricyanide was prepared by adding hydrochloric acid to a solution of Weed's mixture[11] in blood serum. In the absence of protective colloids, the addition of acid to Weed's mixture results in the formation of a heavy insoluble precipitate of the dark blue ferro-ferricyanide. In the presence of the protective colloids of the serum the prussian blue does not precipitate out but remains in colloidal solution. When no more blue color was formed by the addition of acid the solution was brought back to neutrality by the addition of sodium hydroxide. We were now in possession of a colloidal solution of prussian blue in which each particle was necessarily coated with a layer of serum proteins, since any uncoated particles must agglutinate and precipitate out of the solution. The surface properties of such particles which govern adsorption and phagocytosis must depend on the surface coating of serum proteins, while the deep pigmentation of the prussian blue and its insolubility under histologic technics make it possible to recognize the presence of these particles within cells.

11. The formula for Weed's mixture is 1 per cent iron ammonium acetate plus 1 per cent potassium ferrocyanide.

Solutions of prussian blue were prepared in this way with the serum of the experimental animal into which they were to be injected and were then introduced into the anterior chamber. The deposit of the pigment in this case was precisely the same as that previously described. By the end of an hour the surface layer cells of the iris were heavily stained with the dye, but no coloring matter was seen in the deeper tissues or about the blood vessels of the iris.

This result is of importance in several connections. In the first place, it demonstrates the extraordinary lack of specificity of the absorptive powers of the surface layer of the iris. These cells behave as active phagocytes in relation to any colloid or particulate matter with which they are brought into contact, even in relation to the serum proteins of their own animal body. Such an extraordinary voraciousness can hardly be regarded as an accident, for it is evident that this activity of the iris must play a large rôle in keeping the aqueous optically clear, a property that is of considerable value in the functioning of the organism. If whatever touches the iris adheres to its surface, the converse must also be true and whatever the iris touches it must adhere to. This conclusion is especially illuminating in relation to the mechanism of formation of peripheral anterior synechia in glaucoma.

COMMENT

In the first paper of this series [12] we reported experiments in which the reabsorption of fluid was blocked by the injection of the animal's own serum into the anterior chamber, and the rate of formation of the aqueous against normal intra-ocular pressure was then measured. A valid objection to these measurements may be made on the hypothesis that the injected serum proteins reach the perivascular spaces within the iris and there attract fluid into the anterior chamber in virtue of their colloid osmotic pressure. This possible objection was noted at the time that the experiments were done, but a fortuitous accident had made it possible to measure the rate of formation of intra-ocular fluid in a human being under circumstances free from such criticism. Since the flow observed was of the same order of magnitude in the human being and in the experimental animals, we concluded that the osmotic effect of serum proteins on the rate of flow of the aqueous was in all probability negligible in our experiments. This conclusion has been justified in the present study, for if serum proteins do not penetrate into the perivascular spaces of the iris within the first hour after their injection into the anterior chamber, they cannot during the same period exert an appreciable osmotic effect on the rate of formation of intra-ocular fluid.

12. Friedenwald, J. S., and Pierce, H. F.: Circulation of the Aqueous: I. Rate of Flow, Arch. Ophth. **7**:538 (April) 1932.

CONCLUSIONS

The absorption of all colloids, native or foreign, injected into the anterior chamber is extremely rapid.

All such colloids are in the first instance taken up by the surface layer cells of the iris in a process of active phagocytosis. Subsequently, monocytes appear in the tissues and remove the colloid from the eye via the perivascular spaces of the perforating vessels of the sclera. Even serum proteins are removed from the anterior chamber by the same initial route, though their digestion by proteolytic enzymes also plays a rôle.

The phagocytic activity of the surface layer of the iris is of physiologic importance in relation to the optical clarity of the aqueous.

The same property explains the ease with which peripheral anterior synechia are formed in glaucoma.

ACUTE METASTATIC SYPHILITIC CORNEAL ABSCESS

A CLINICAL AND HISTOPATHOLOGIC STUDY

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When in 1915 Fuchs [1] gave a classic description of a corneal lesion which he called "keratitis pustuliformis profunda," he left open only the question of the earliest symptoms of the disease and its etiology.

Concerning these two points Meller [2] and Seefelder [3] in the following years gave valuable additional information supported by the rapidly increasing general use of serologic tests.

Meller had the opportunity to observe the incipient symptoms of the corneal lesion in a patient who showed the fully developed picture in the other eye. He reached the conclusion that the keratitis is probably primary or at least coordinate with the severe hypopyon iritis. In Meller's and Seefelder's cases the Wassermann reaction of the blood was positive, and the course of the disease was favorably influenced by antisyphilitic treatment, resulting in useful visual acuity.

Other cases with similar therapeutic results were reported by A. Fuchs,[4] Schneider,[5] Enroth,[6] Granström,[7] von Hippel [8] and Schaefer.[9] Of the sixteen patients of E. Fuchs four were known with certainty to have a syphilitic infection, and in only one of the remaining twelve could it be ruled out, and this case was not considered typical by Fuchs. As only local therapy was employed the end-results in all of these sixteen eyes was unfavorable.

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2. Meller, J.: Zur Aetiologie der Keratitis pustuliformis profunda, Centralbl. f. prakt. Augenh. **42**:1, 1918.

3. Seefelder, R.: Zur Aetiologie der Keratitis pustuliformis profunda, Arch. f. Augenh. **92**:1, 1922.

4. Fuchs, A.: Ein Fall von Keratitis pustuliformis profunda bei sekundärer Lues, Ztschr. f. Augenh. **41**:357, 1919.

5. Schneider, R.: Zur Keratitis pustuliformis profunda, Klin. Monatsbl. f. Augenh. **69**:238, 1922.

6. Enroth, E.: Ein Fall von luetischer Hypopyonkeratitis, Acta ophth. **4**:271, 1927.

7. Granström, K. O.: A Case of Keratitis Pustuliformis Profunda, Acta ophth. **7**:330, 1929.

8. v. Hippel, E., in Henke, F., and Lubarsch, O.: Handbuch der speziellen pathologischen Anatomie und Histologie des Auges, Berlin, Julius Springer, 1928, vol. 1, p. 241.

9. Schaefer, F.: Ueber einen Fall von Keratitis pustuliformis profunda, Arch. f. Augenh. **106**:559, 1932.

Owing to the rarity of this corneal disease clinical and histopathologic reports have been few. Besides E. Fuchs, who studied four of his sixteen cases histologically, only Igersheimer [10] obtained a histologic specimen from an eye in this condition. His patient was first seen four weeks after the onset of a violent unilateral hypopyon iritis. Secondary glaucoma had developed, and stippling of the corneal epithelium prevented observation of deeper corneal changes. Contrary to the uniformly favorable reports of the influence of antisyphilitic therapy on this disease, Igersheimer's patient did not improve after two injections of neoarsphenamine, which, however, were given rather late. The eye was enucleated eight weeks after the onset of the violent symptoms.

Four cases in which the condition was treated successfully were reported from the Axenfeld clinic by Bryn.[11] He was the first to apply the name "acute metastatic syphilitic abscess" to this corneal involvement, as its syphilitic origin was then well recognized.

The characteristic features of the fully developed disease are relatively sharply defined yellowish infiltrates in the deep layers of the cornea, separated from the limbus by a clear or only faintly opaque zone and associated with hypopyon iritis. It is not, however, until the third or fourth week that this characteristic picture presents itself, as Meller's observation and the one I report show. In the earlier stages only the circumscribed deep infiltrate with even the faintest central yellowish discoloration suggesting an abscess, and the presence of iritis, which shows a gradual transition from the low grade infiltrative type to a purulent exudative form, suggest the correct diagnosis.

REPORT OF A CASE

The following clinical observations were made as early as two weeks, and the histologic specimen was obtained as early as six weeks, after the onset of the disease.

History.—J. S., aged 50, visited the ophthalmic clinic of Rush Medical College complaining of photophobia, pain and slight redness of the right eye of two weeks' duration. He had never before had an inflammation of his eyes or any other severe illness and denied knowledge of a venereal infection.

On his first visit the visual acuity of the right eye was 1.2 —2 and that of the left eye 1.0—4. There was moderate photophobia plus some ciliary injection of the right bulb, more intense superiorly. In the upper half of the cornea there was an approximately triangular deep infiltration with its apex about opposite the upper pupillary margin and its base contiguous with the limbus. The central portion of this infiltrate was faintly yellowish, fading gradually into the delicate

10. Igersheimer, J.: Anatomischer Befund einer Keratitis pustuliformis profunda, Arch. f. Ophth. **123**:468, 1930.

11. Bryn, A.: Ein Beitrag zur Kenntnis des acuten metastatisch-syphilitischen Hornhautabscesses, Klin. Monatsbl. f. Augenh. **73**:680, 1924.

smoke-gray opacity of the peripheral portion. Numerous folds of Descemet's membrane gave the lesion a striate appearance. There was no vascularization of the cornea at this time. Numerous cellular elements were suspended in the aqueous, and a few larger precipitates were scattered over the posterior corneal surface. The iris did not differ in color from that of the other eye; the pupil and the fundus were normal. The left eye was normal. The tentative diagnosis of keratitis pustuliformis profunda was made.

The patient did not return to the clinic of Rush Medical College for further examination and treatment but was seen three weeks later in the ophthalmic clinic of another hospital, where the following status was noted: The visual acuity of the right eye was equal to perception of light; that of the left eye, to 1.0—4. There was marked mixed injection in the right bulb. No superficial corneal defect was found. An area of deep vascularization, 2 mm. wide, adjoined the upper limbus; no other corneal involvement was mentioned since the entire cornea appeared yellowish against the massive hypopyon which completely filled the anterior chamber. The intra-ocular tension was 55 mg. of mercury with the Schiötz tonometer.

As the clinical findings were not correctly interpreted and the patient suffered severe pain the eye was removed six weeks after the onset of the disease and sent to the laboratory of Rush Medical College.

Fig. 1.—Representation of the corneal lesion two weeks after its onset.

The patient obeyed an invitation to revisit the ophthalmic clinic of Rush Medical College and was finally brought to submit to a general physical examination. The Wassermann reaction in the blood was strongly positive. No other internal signs of a syphilitic infection were found.

The enucleated eyeball was fixed in Müller's fluid and sectioned serially in the vertical direction. Its external dimensions were normal.

Histologic Observations.—In all sections there was a dense lymphocytic infiltration at the limbus at both sides of the cornea with moderate engorgement of the conjunctival and anterior ciliary vessels. The corneal epithelium was moderately uneven and irregular owing to hydrops of groups of its cells. Bowman's membrane was normal. While the anterior lamellae were regular, the middle and posterior layers deviated from the parallel arrangement because of an interlamellar polymorphonuclear leukocytic invasion, increasing in the axial direction. In three different places these interlamellar slits became pockets filled with partly well preserved leukocytes, cell débris, disintegrated substantia propria and peculiar vesicular cells with faintly staining oval or round nuclei, which may have been degenerated keratoblasts. One of the abscesses occupied the center of the cornea, and the largest was near the upper limbus in the most posterior layers of the cornea. There was no direct continuity between this deep abscess and the exudate in the anterior chamber, Descemet's membrane being completely intact. From

the anterior ciliary vessels and the rami perforantes of the upper limbus numerous new blood vessels extended into the cornea and reached the upper and anterior border of the largest abscess, in the immediate neighborhood of which intracorneal hemorrhages from these new-formed capillaries were present. The corneal endothelium was to a large extent absent, and where it was still preserved it was detached from Descemet's membrane by a dense layer of polymorphonuclear leukocytes. Around the three zones of densest infiltration there was also considerable proliferation of the fixed cells of the cornea in addition to the leukocytic invasion.

The anterior chamber was almost completely filled by serofibrinous and cellular exudate. The cells were mostly polymorphonuclear leukocytes in various stages of degeneration, cell shadows, macrophages loaded with cell débris and a few

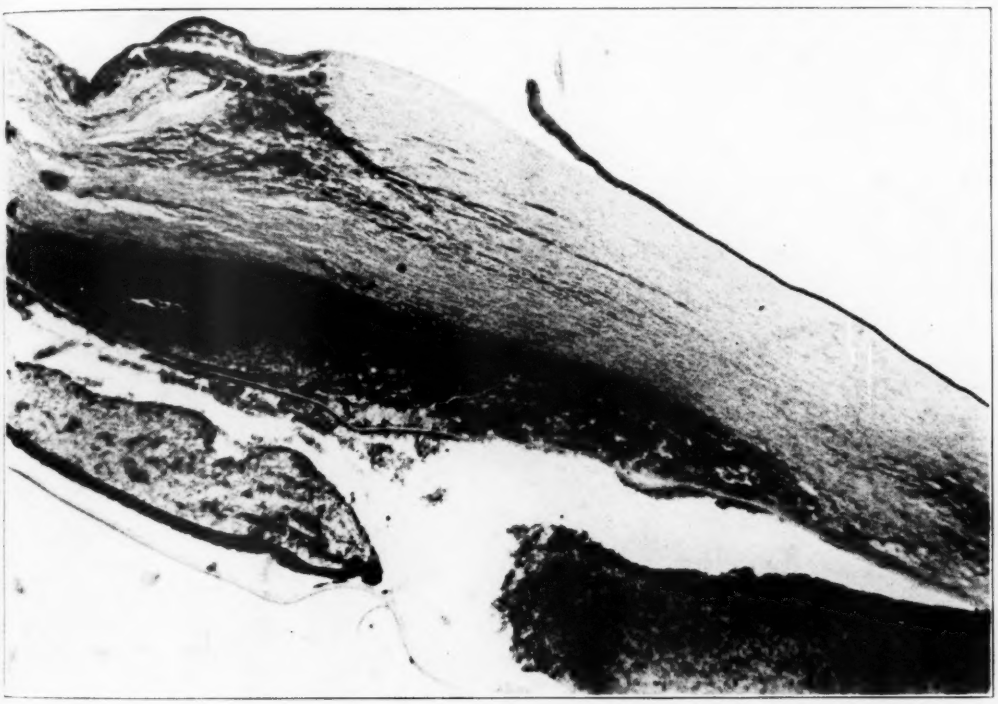

Fig. 2.—Photomicrograph showing deep corneal abscess six weeks after its onset.

lymphocytes. There were also some cell conglomerations partly suspended in the aqueous and partly applied to the posterior corneal surface, having the appearance of true precipitates, in which the nuclei of round cells predominated.

The iris had a dense polymorphonuclear leukocytic infiltration throughout the pupillary portion. The infiltrate of the stroma and crypts was in direct contact with the exudate in the anterior chamber. In the ciliary portion of the iris an infiltration with lymphocytes and plasma cells prevailed. The blood vessels of the iris were markedly congested, and free hemorrhages were scattered throughout the stroma. The root of the iris and the anterior portion of the corpus ciliare had only moderate mixed infiltration. Clumps of pigment partly embedded in fibrinous

deposits rested on the anterior surface of the lens. The pigment layer of the iris was intact except for a few short posterior synechiae at the pupillary margin. The upper ciliary processes were lined by groups of polymorphonuclear leukocytes.

There were very few changes in the posterior segment of the eye. Here and there was a small focus of lymphocytic infiltration in the anterior portion of the choroid. The changes in the retina were limited to a very mild periphlebitis of a few venous branches. The optic nerve alone had a considerable edematous imbibition of the prelaminar and interlaminar portions. Thus the choroidal portion of the lamina cribrosa was separated from the scleral portion and was visible as an arcade-shaped, distended strand of connective tissue pushed forward into the nerve head. The edema extended into the subretinal space around the nerve head causing a low peripapillary detachment, and the subretinal fluid contained a few cellular elements, such as wandering cells and glia cells, carried out into this fluid from the nerve by mechanical force.

The posterior ciliary vessels outside of the bulb showed elastic lamellation and subendothelial and endothelial proliferation leading to occlusion of some vascular lumens.

COMMENT

Within as short a time as three weeks the eye of the patient presented two different types of uveal inflammation. Associated with the incipient stage of the corneal lesion was a chronic infiltrative type of iridocyclitis with true precipitates applied to the cornea and a moderate increase of the cellular elements in the aqueous. This is not the type of secondary iridocyclitis which one is accustomed to find in purulent involvements of the cornea. On the other hand, the corneal lesion, which already at this stage betrayed its purulent character, could not easily be considered an involvement secondary to this type of iritis. Thus the chronological appearance of the corneal lesion in relation to the uveal symptoms suggests that they were coordinate manifestations of the same disease.

The transition from this first stage to the purulent exudative type of iridocyclitis which characterizes the maximum involvement seems to be typical for this disease.

In the histologic picture these two stages could be identified by the coexistence of true precipitates in the aqueous and on the cornea with the purulent exudate of the later stage.

In evaluating the other histologic observations the fact deserves emphasis that no ruptures of Descemet's membrane were found in spite of the extensive corneal abscess. Igersheimer and Fuchs, in three of his specimens, found defects of Descemet's membrane. In only one of Fuchs' specimens was the membrane intact, and there was only an erosion of the endothelium with no purulent infiltration of the cornea, but proliferative changes only. Both Fuchs and Igersheimer concluded, mainly on the basis of their histologic observations, that the corneal involvement was secondary to the severe iritis and probably of toxic origin.

The edema of the optic nerve with the peripapillary retinal detachment, which represented the only marked alteration of the posterior segment, was probably a consequence of the status glaucomatosus which existed at the time of enucleation. No involvement of the optic nerve was present at the time of the first clinical examination, when the vision was 1.2. Degenerative changes in the uveal vessels and in the optic nerve as Fuchs found them in his specimens were absent in the preparation which I studied. There was no extensive destruction of tissues anywhere at this stage.

The next question concerns the mode of infection. Since the coordination of the corneal and the uveal symptoms is reasonably sure, the most probable mode of infection would be metastasis of abundant virulent spirochetes into various parts of the eye. This would explain not only the fact that in most cases the occurrence is unilateral but also the rarity of the disease, although the latter may be modified by better diagnostic facilities and earlier and better antisyphilitic treatment. The mode by which the spirochetes reach the central portions of the cornea, where the typical lesions are usually found, has not yet been ascertained. An invasion from the vessels of the limbus is probable. Owing to their own motility the spirochetes would be able to penetrate and wander through tissues in a short time without necessarily causing injuries of all the tissues through which they pass. Thus the marginal zone would remain relatively clear. Against an infection from the anterior chamber speaks the fact that no spirochetes have ever been obtained from the aqueous of such patients.

SUMMARY AND CONCLUSIONS

Histologic examination of an eye enucleated six weeks after the onset of a metastatic syphilitic corneal abscess revealed pathologic changes all of which were of such a kind as to admit of repair leading, if not to a restitutio ad integrum, at least to a preservation of the eyeball with useful vision.

The corneal and uveal lesions in metastatic syphilitic abscess are coordinate manifestations as suggested by the clinical picture observed as early as two weeks after the onset of the first mild symptoms, by the histologically demonstrated absence of any defect of Descemet's membrane and by the fact that spirochetes have never been found in the aqueous.

The most probable mode of infection is a metastasis of spirochetes into the iris and cornea.

Despite its seeming rarity, the clinical entity of metastatic syphilitic corneal abscess, when recognized in an early stage, offers the ophthalmologist one of the most gratifying opportunities for a spectacular result in the entire range of antisyphilitic therapy of diseases of the eye.

EMPIRICAL TREATMENT OF UVEITIS

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Notwithstanding recent advances in ophthalmic diagnosis and treatment, a great number of cases of acute and chronic uveitis are seen in which exhaustive search reveals no etiologic factor. This article is limited to a résumé of the usual treatment in such cases. Complications are not considered.

MYDRIATICS

Since in all cases of acute and in some of chronic uveitis mydriatics are used, their selection, dosage and method of administration are interesting. Atropine sulphate, U. S. P., is the mydriatic of choice, the strength varying from 1 to 5 per cent in solution to actual crystals. The weaker solutions with often repeated applications are preferable to those of greater strength. Since atropine sulphate is absorbed best through the cornea, instillations made with the patient lying down give better results, for a more satisfactory corneal contact is thus obtained. Subconjunctival injections of cocaine hydrochloride, U. S. P., epinephrine hydrochloride, U. S. P., and atropine sulphate are frequently used particularly when posterior synechiae are present or impending. Donovan has suggested subconjunctival injection of from 1 to 2 per cent salt solution to which is added a "little ethyl morphine hydrochloride and a a trifle of morphine." I have been using 2 drops of 4 per cent cocaine hydrochloride, 2 drops of 1:1,000 epinephrine hydrochloride or 3 per cent ephedrine sulphate, 2 drops of 1 per cent atropine sulphate and 10 drops of physiologic solution of sodium chloride, distributing the dose around the limbus or concentrating the attack opposite the point of greatest adhesions. This injection can be repeated daily for from three to five days; the results have been satisfactory. A localized subconjunctival abscess may result if aseptic precautions are not carefully observed. The site of injection may be touched with a small application of 10 per cent silver nitrate or tincture of iodine just before the needle is introduced. For the persistent posterior synechae Würdemann employs suction vibratory massage for from two to three minutes, watching for bleeding. This may be repeated several times. Since the degree of dilatation is inversely proportional to the amount of inflammation of the iris, other measures for the relief of this inflammation should be emphasized early in the course of treatment. Mild mercurous chloride, 3 grains (0.2 Gm.) in 1 dose followed by a saline purge in the morning will, according to Pratt and others, cause dilatation of the

pupil in early cases when atropine sulphate alone fails. In many instances the failure to dilate is not due to adhesions but to the irritable and inflamed condition of the iris. Dilatation when secured, puts the iris and ciliary body at rest and lessens the pain. The great importance of systemic measures is only mentioned here but will be discussed later in this paper.

If the patient is sensitive to atropine sulphate one may substitute duboisine sulphate (from 0.25 to 1 per cent), hyoscine hydrobromide U. S. P. (from 0.1 to 1 per cent) or scopolamine hydrobromide, U. S. P. (from 0.2 to 1 per cent). Scopolamine hydrobromide seems to be most acceptable to the patient. Initial sensitiveness can be determined by the Pirquet test using 1 per cent solution of atropine sulphate. Usually, however, this sensitiveness is acquired and can be lost after a period of rest. One should not be too dogmatic and tell such a patient that atropine can never be used again, since this advice may needlessly deprive him of a useful drug in the future. The hypersensitive reaction may manifest itself in the intra-ocular structures as well as in the conjunctiva and skin. One patient, a physician, who was extremely sensitive to any form of belladonna felt that his iritis repeatedly became worse after taking Lapactic pills (a proprietary laxative preparation containing belladonna) for constipation.

Epinephrine pack, epinephrine bitartrate (2 per cent) or an epinephrine substitute can be used in conjunction with atropine sulphate or perhaps in place of the latter drug if increased tension develops. It is hardly necessary to emphasize the importance of continuing the treatment of the acute uveitis even if increased tension develops. Repeated paracenteses may be indicated. Levoglaucosan (an epinephrine substitute) is regarded as too powerful and is not recommended; the others can be given once daily for from three to five days and repeated later if necessary.

A few special combinations have been offered. O'Connor applies an ointment of 4 per cent atropine sulphate, 1 per cent epinephrine, U. S. P. (pulverized), and 4 per cent cocaine with white petrolatum, gives it time to act and follows with 10 per cent ethyl morphine hydrochloride and diathermy. He has reported concentrated and prolonged action due to the triplicaton of the drugs and stated that it is as effective as the subconjunctival injections mentioned in a foregoing paragraph. O'Brien submitted a combination of cocaine hydrochloride (5 per cent), scopolamine hydrobromide (0.2 per cent), atropine sulphate (2 per cent) and epinephrine bitartrate (2 per cent) to be instilled once daily with scopolamine hydrobromide (0.2 per cent) alone every three or four hours.

Ethyl morphine hydrochloride solution (from 1 to 10 per cent) or powder is advocated by many in conjunction with the mydriatics. I

have always been disappointed with the result obtained from this drug in acute uveitis. In a condition in which a marked engorgement of the blood vessels is already present it does not seem rational to employ a substance that decidedly increases this congestion. I am aware of the accepted statement that ethyl morphine hydrochloride ameliorates the severe pain, but I have noticed that frequently the patient is made decidedly more uncomfortable by the effect of this drug and becomes more comfortable after its use is discontinued. Certainly the weaker solutions are preferable and never the subconjunctival injection of this drug. In cases of chronic noninflammatory uveitis this drug has a definite value.

FOREIGN PROTEINS

The use of foreign proteins in the treatment of ocular diseases is now accepted without question. Benedict has stated that a physician who fails to employ this treatment in a case of penetrating ocular injury in which sympathetic ophthalmia develops in the other eye may be considered legally guilty of neglect. The variety of choice is interesting. Many attribute a large part of the beneficial effect to the high fever produced, and several discontinue the use of the salicylates at this time in order not to interfere with the elevation of temperature. Others consider the chills and fever of no consequence. A few use the immunogens and other bacterial antigens which act more specifically and not as foreign proteins.

Of the proteins producing strong reactions typhoid vaccine and whole milk are the favorites. The dosage varies much with individual doctors. Wolfe starts with 1 cc. of boiled milk and gradually increases the amount to 4 or 5 cc., but most of those who have reported give from 5 to 10 cc. as the initial dose and repeat this dose every other day depending on the reaction. Benedict uses milk when the condition is acute and has come to look on the chills and fever following as inconsequential. Milk derivatives with milder reactions are often injected, such as a protein of milk, which Peter administers intramuscularly with an initial dose of 0.5 cc., increasing the amount daily by 0.5 cc. until the maximum dose of 5 cc. is reached. When the condition is chronic he holds the maximum dose to 2 cc., given every other day. A nonspecific protein from milk is given daily by Clay in 2 cc. doses for four or five days. Jervey uses an injectible milk product in sufficient amount to produce a good reaction and repeats the dose every day or every other day until 5 or 6 injections have been given. Typhoid vaccine is the most preferred of the proteins used. Most ophthalmologists start with 25,000,000 bacilli injected intravenously or intramuscularly, administer the second injection after the fever has been normal for twenty-four hours and follow with the third and subsequent injections on alternate days, increasing the dose at each injection according to the previous reaction. How-

ever, Vail starts with 10,000,000 bacilli and increases the dose by 10,000,000 every other day until a maximum of at least 40,000,000 is reached, while O'Brien begins with 25,000,000 bacilli injected intravenously, doubles this every day until the dose reaches 200,000,000 and then continues to administer a daily dose but increases it by only 50,000,000 each time. He gives from 6 to 10 injections.

Diphtheria antitoxin has few advocates. Heckel is the only one to give it first place. He injects from 5,000 to 20,000 units daily for four or five days. Vail, Wilkinson and Greenwood have mentioned it, and Terry has condemned it. The importance of first testing the sensitiveness of the patient to this protein must be emphasized. In fact, before any foreign protein is used such a preliminary test should be made.

A bacterial antigen is enthusiastically recommended by Wiener. Würdemann favors rheumatism-bacterial filtrates of pathogenic organisms, especially when the uveitis is chronic. Lancaster has suggested typhoid vaccine or milk and has listed horse serum as a third possibility. A nonspecific substance containing albumin, lipoid and fat is favored for mild reactions. A killed broth culture of Prodigiosus and Streptococcus fluid can be given in doses of 3 minims (0.2 cc.) in the arm muscles. The reaction occurs from four to five hours after the injection, allowing the patient time to reach home before the chill sets in, which lasts for from fifteen to thirty minutes and is followed by an elevation of the temperature ranging from 101 to 103 F. (rectal) and lasting from twelve to twenty-four hours. Joseph Levine prefers the foregoing fluid. Calcium gluconate is often given intravenously every day or every other day following the course of foreign proteins. Ten cubic centimeters of a 10 per cent solution is the usual dose.

The general condition of the patient must be carefully considered before a foreign protein is administered, the contraindications being fever, low vitality, heart disease, etc. In my experience a bacterial antigen advocated by Wiener has given good results and its use can be continued for from 15 to 20 doses. For a strong reaction typhoid vaccine is preferable. The proteins producing the milder reactions should be tried first, but if no improvement occurs in three or four days stronger reactions are needed.

SYSTEMIC TREATMENT

In the way of systemic treatment there is considerable uniformity of opinion. Practically all ophthalmologists who have recorded their procedures use either sodium or acetyl salicylate. The dosage recommended varies considerably, some using 30, 40 and 100 grains (1.9, 2.5 and 6.4 Gm.) daily, while others follow the Gifford plan of giving 1 grain (0.06 Gm.) per pound (0.5 Kg.) of body weight daily, depending on the toleration. Oral administration is sufficient since animal

experimentation reveals that the drug given orally shows up early in the aqueous. On the whole, moderate doses are preferable.

Arnold Knapp has mentioned a product containing cinchophen sodium, sodium salicylate and p-aminobenzoyl-diethyl-amino-ethanol hydrochloride, given in doses of from 5 to 10 cc. a day intravenously. Gifford has warned against extensive use of cinchophen (atophan).

Mixed treatment and mercury rubs have been advocated for their alterative effect. It is probable that the old time remedy of mercury rubs has been neglected, as patients sometimes seem to improve on rubs after other measures have failed. Knapp, Greenwood and O'Brien have recommended Burnham's combined treatment (pilocarpine hydrochloride, U. S. P., from $\frac{1}{12}$ to $\frac{1}{6}$ grain [0.03 to 0.01 Gm.] in a series of 10 subcutaneous injections given at the rate of one a day at from 3 to 4 p. m. The patient lies down for one and a half hours; he is then wiped dry and dressed but remains in the house the rest of the day. The administration of mercury and iodide is continued during the treatments and between the courses, which may be repeated every six weeks. The size and frequency of the doses of pilocarpine hydrochloride vary with different clinicians.

Eugene Lewis has emphasized a minimal total caloric intake starting with 1,000 to 1,200 calories daily and increased fluid intake (one 8 ounce [236 cc.] tumblerful of fluid per ten pounds [4.5 Kg.] of body weight daily, only 1 tumblerful being given every forty to sixty minutes and scheduled preferably for waking hours before 7 p. m. to avoid nocturia). An initial fast of from seven to twenty-one days is advised, followed by gradual caloric increase with proper balance between carbohydrates, fats and proteins.

Leeches have been mentioned by Green, Heath and Greenwood.

General elimination and proper tonic treatment are important. I feel that the intestinal tract has not been given sufficient attention, especially in cases in which the uveitis is chronic, though several have recommended mild mercurous chloride for catharsis, etc. Nightly administration of liquid petrolatum emulsified with agar with use of alkalis or some such mild laxative is not infrequently of definite benefit.

TREATMENT IN CHRONIC UVEITIS

None of the ophthalmologists who have reported are encouraging regarding the results of treatment in chronic uveitis. In general the treatment is similar to that for the acute condition with the exception that milder remedies are used. Many of the cases without definite cause are assigned to the tuberculous group. This pigeon-hole is probably used too often. One should not be afraid to admit that the cause cannot be found, and certainly the patient should be given the benefit (uncertain though it is) of a treatment more extensive than administration of

tuberculin and general care. In the absence of inflammatory signs most ophthalmologists use no mydriatic. If any is used scopolamine hydrobromide (0.2 per cent) is probably the most satisfactory since it is milder and produces less reaction. The foreign proteins causing a mild reaction are preferable since they are to be used over a long period of time. Lillie, however, gives large doses of typhoid vaccine in a series of 8 injections. Berens employs special vaccines of streptococci and staphylococci in small doses for an extended period in the hope of desensitizing the patient, thus introducing the question of allergy.

Gradle, Heath, Benedict and Lillie, and probably others, give intravenous injections of sodium gold thiosulphate, which produces capillary hyperemia by paralyzing the contractile element of the capillaries. Benedict starts with 10 mg. and increases the amount by 5 mg. at each injection, giving 2 injections a week, until a maximal dose of 50 mg. is reached. From 20 to 25 injections are given in one course which may be repeated after from two to three months. There may develop a serious hypersensitive reaction similar to that obtained with arsenicals, namely, exfoliative dermatitis. Benedict has recommended its use in cases in which chronic and nonactive tuberculous uveitis have not responded to tuberculin or any other foreign protein.

F. J. Pratt gives 2 units of insulin daily for the first week and then twice a week for from two to three weeks, and if punctate keratitis is present he gives calcium gluconate intravenously, as previously mentioned.

TUBERCULIN

Howard and Wiener have called attention to the diagnostic value of the Schilling differential count. A shift to the left in stab cells or a shift to the right in lymphocytes is suspicious, and if it is continuous and increases as the diagnostic doses increase the diagnosis is established even if no fever or local reaction has developed (Howard). The danger of the diagnostic test is emphasized by several, especially if the posterior segment is involved. In treatment the usual initial dose is very small, probably 0.00001 mg. of old tuberculin; it is repeated once a week in gradually increasing amounts over a period of several months.

HEAT

Practically all use heat in some form. O'Connor, Walker and Gradle use diathermy, thus generating the heat in the tissues. Walker thinks diathermy is probably the best part of his treatment. Greenwood has called attention to the Altherm eyepad. Pratt has suggested the carbon light bulb in a holder held by the patient. Many use infra-red rays in some form. Donovan has mentioned the practical application of the common bathroom electric heater.

Clinical Notes

MYOPIA AND EXOPHORIA

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The article on "Muscle Imbalance in Myopia" by Marlow [1] in the April issue of the ARCHIVES OF OPHTHALMOLOGY stressed an element in the etiology of progressive myopia which has been too long overlooked. In fact, in a lecture on myopia before the Section of Ophthalmology of the New York Academy of Medicine (Dec. 17, 1934) all possible factors in the etiology of myopia, simple and progressive, were enumerated and briefly discussed, but the rôle of exophoria as a factor was hardly mentioned. This oversight has now been corrected in Marlow's splendid contribution. However, there is still one phase which has not been fully presented and which I wish to discuss briefly.

Aside from axial myopia, due to stretching of the sclera, there is a slowly progressive, low grade myopia, especially in children, which does not seem to be connected with a stretching process; it seems to be caused primarily by a permanently increased tonus in the accommodation center and in the ciliary muscles. Myopia due to such a hypertonic state of the neuromuscular accommodative mechanism may well be called tonic myopia. That tonic myopia is of frequent occurrence is evidenced in some of the cases cited by Marlow, though he referred to this phenomenon as a spasm of accommodation. The fact that the low grade myopia noted during cycloplegia sometimes disappears after prolonged treatment with prisms base in indicates that the "false" myopia is more the result of a heightened, persistent nerve and muscle tonus than of spasm. However, this is perhaps a quibble on words, especially when one has in mind the so-called tonic spasm.

The close association of myopia and exophoria has long been recognized and variously explained. The current explanation has been that myopia is primary and exophoria secondary, the latter resulting from the close interrelation between accommodation and convergence. It has been argued that as the myopic eye has little need of accommodation, the convergence center is indirectly weakened by being deprived of the additional stimulus from the accommodation center. The result is an insufficiency of convergence for distant vision and more so for near vision. However, in many cases at least, and several are cited by Marlow, the process is just reversed; exophoria is primary and myopia

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1. Marlow, F. W.: Muscle Imbalance in Myopia, Arch. Ophth. **13**:584 (April) 1935.

is secondary. It is frequently found that correcting the myopia has a slight, if any, effect on the existing exophoria, whereas correcting the exophoria has a definite effect on lessening the amount or the progress of the myopia.

Marlow explained the rôle of exophoria in the etiology of axial myopia through the increased tension of the muscles, which tends to facilitate a stretching of the sclera. I wish to add that the development in certain cases of a low degree of myopia, appropriately called tonic myopia, may be due to a permanent hypertonic condition of the accommodation center produced by primary exophoria.

The existence of a convergence center has long been conceded, but the existence of a divergence center has for a long time been denied. Exophoria in general was considered to be a passive state due to an insufficiency of convergence. But more and more evidence has recently come to light proving the existence of an active divergence center. In the same issue of the ARCHIVES are two contributions, one by Bruce [2] and another by Bielschowsky,[3] predicating the existence of a divergence center. With this in mind exophoria need not be regarded as a passive state resulting from a hypotonic convergence center, but rather as an active state due to a hypertonic divergence center. To overcome such hypertonicity of divergence, excessive stimulation must be constantly sent to the convergence center, with an accompanying excessive stimulation to the accommodation center. The overaccommodation, of course, tends to blur distant vision, but blurred vision is more easily tolerated than double vision. In fact, the slight blur for distance that is due to a slowly developing low grade myopia may even escape the child's notice.

It is true that myopia does not tend to develop in all children showing exophoria. The reason for this lies in the varying intensity of the association between accommodation and convergence. When this association is very close or rigid, the continuously overactive convergence tends to produce a hypertonicity of accommodation and resultant tonic myopia. When the association is weak, no such result follows, largely because of a desire for clear as well as single vision. It has long been recognized that the intensity of association between accommodation and convergence varies in different persons. Maddox referred to this in explaining why in some hyperopic children convergent squint develops while in other children who are equally hyperopic it does not.

The physician's most important task in a case of myopia is to check its increase. To that end, Marlow advocated the use of prisms base in to correct the exophoria. However, when there is a low degree of myopia or when the exophoria is not high, for instance 4 prism diopters or less, an alternative procedure is to give exercises which will weaken the association between accommodation and convergence. Such exercises given on the ordinary stereoscope strike at the root of the trouble, which is a "tight hook-up" between accommodation and convergence. Especially in children, in whom all innervational habits are

2. Bruce, G. M.: Ocular Divergence: Its Physiology and Pathology, Arch. Ophth. **13**:639 (April) 1935.

3. Bielschowsky, A.: Lectures on Motor Anomalies of the Eyes: III. Paralyses of the Conjugate Movements of the Eyes, Arch. Ophth. **13**:569 (April) 1935.

still relatively recent, it is not at all difficult to loosen up this association and develop a marked independence of action. If these exercises alone suffice, they are to be preferred to the continuous wearing of prisms base in.

SUMMARY

Exophoria may produce axial myopia, as Marlow has shown, by a stretching process resulting from compression by the extra-ocular muscles. But this is only one phase in the muscular etiology of myopia. Another phase is the effect of a primary exophoria producing what may be called tonic myopia by a constant overstimulation of the accommodative mechanism because of the constant overstimulation of convergence. This type of myopia will develop only in exophoric children in whom the association between accommodation and convergence is especially firm. To overcome the development of such myopia and especially to stop its increase, stereoscopic exercises which weaken the association between the two functions are especially useful.

37 West Ninety-Seventh Street.

BILATERAL BUPHTHALMOS ASSOCIATED WITH NAEVUS FLAMMEUS

Report of a Case

CHARLES A. PERERA, M.D.,* NEW YORK

The rare condition in which congenital vascular nevi are associated with glaucoma has been of interest to ophthalmologists since the first case was reported by Schirmer [1] in 1860. This clinical picture has been reported in the literature at least sixty-five times since then, the glaucoma having been bilateral in five cases. Intracranial calcification, changes in the bones of the skull and body and neurologic disturbances have been noted in some of the cases. The literature has been well reviewed by O'Brien and Porter [2] and by Dunphy.[3]

The rarity of cases in which there is bilateral increase in the intraocular pressure prompts the report of the following case.

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* Resident in Ophthalmology, Institute of Ophthalmology, Presbyterian Hospital.

Read before the Ophthalmologic Section of the New York Academy of Medicine, April 15, 1935.

1. Schirmer, Rudolph: Ein Fall von Teleangiektasie, Arch. f. Ophth. **7**:119, 1860.

2. O'Brien, C. S., and Porter, W. C.: Glaucoma and Naevus Flammeus, Arch. Ophth. **9**:715 (May) 1933.

3. Dunphy, Edwin B.: Glaucoma Accompanying Naevus Flammeus, Tr. Am. Ophth. Soc. **32**:143, 1934.

REPORT OF CASE

Peggy H., a 14 month old white child, was admitted to the Babies Hospital in September 1934 because of birth marks on the head and body and because of rapid enlargement of the head. The family history was not important. The child's birth was difficult as a result of the large size of the head. Development was normal up to the time of admission. There was a history of "thymus trouble" at the age of 5 months.

Physical examination revealed a well nourished child with a diffuse purplish or indigo vascular nevus covering most of the face and scalp and the right side of the body. The skin in those regions was puffy and thickened. The right upper extremity appeared larger than the left. The head was larger than normal, measuring 55 cm. in circumference, and showed frontal, parietal and occipital prominences. The anterior fontanel was open, admitting three fingers. The lungs, heart, abdomen and deep reflexes were normal. The blood pressure in the right arm (160 systolic and 120 diastolic) was higher than that in the left (140 systolic and 80 diastolic).

Naevus flammeus of the face and head, enlargement of the corneas and changes in the skull. Note the contrast with the normal skin of the left hand and forearm.

Ocular examination showed that all the lids were thickened by hemangiomatous lesions. There was exotropia of 10 degrees, the child fixing with the left eye. The tension (Schiötz) in the right eye was 45 and in the left eye, 35. There was no evidence of paresis. The palpebral conjunctiva was injected and contained dilated blood vessels. Both globes seemed larger than normal, the horizontal diameter of the corneas measuring 14 mm. The cornea of the right eye was slightly hazy. The anterior chambers were deep. The irides were greenish, with diminished markings. The pupillary reflexes were normal. Both fundi appeared redder than usual, and the disks showed moderate pathologic cupping. There was increased tortuosity of the retinal vessels but no evidence of localized choroidal hemangiomas.

A diagnosis of bilateral buphthalmos was made, and the patient was transferred to Dr. Dunnington's service at the Institute of Ophthalmology of the Presbyterian Hospital.

Laboratory investigations of the blood, urine and spinal fluid gave normal results.

Dr. Andrews, of the dermatologic department, advised treatment of the cutaneous lesions with ultraviolet radiation.

Roentgenographic studies by Dr. Caffey revealed enlargement of the skull due to thickening of the frontal bones, curved shadows of extensive calcification being noted in the posterior temporal regions. The bones of the right arm were larger than those of the left. Encephalography showed a deepened subarachnoid space and unusually heavy cortical markings on the right side, indicating a great deal of generalized defect of the brain tissue. The ventricular system failed to fill with air. These observations were interpreted as indicating the presence of intracranial hemangiomas.

Corneoscleral trephining with peripheral iridectomy was performed on both eyes. Healing was uneventful, and the intra-ocular tension was reduced to within normal limits.

The prognosis depends on the possible occurrence of intracranial hemorrhages.

COMMENT

The etiology of the glaucoma in these cases is probably related to intra-ocular vascular lesions. Studies of the fourteen globes examined histologically showed hemangioma of the choroid in ten instances. A number of theories have been advanced to explain the increase in tension, among them being the following: increased transudation through the choroidal vessels, destruction of the sympathetic nerve supply, malformation of the filtering angle of the anterior chamber and chemical changes in the intra-ocular fluids as a result of increased permeability of the vessels.

Miotics have been used in the treatment, according to the reports of cases. In Knapp's [4] case, presented in 1927, miotics were employed, and then trephining of the corneosclera of each eye was performed.

635 West 165th Street.

4. Knapp, Arnold: Glaucoma in Generalized Vascular Nevus of the Skin, Arch. Ophth. **57**:219 (May) 1928.

Ophthalmologic Review

RÔLE OF BACTERIUM GRANULOSIS IN TRACHOMA

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LOS ANGELES

Noguchi's announcement in 1927 that he had discovered a new organism, namely, Bacterium granulosis, which was responsible for the production of trachoma, attracted world-wide attention. The reputation of Noguchi as one of the outstanding investigators in the field of bacteriology and the impressiveness of his preliminary reports had aroused hopes that one of the most puzzling of the ophthalmologic problems had been solved. While further communications from Noguchi were eagerly awaited, the sad news arrived that he had died a martyr to the cause of medical research.

The work so ably begun by Noguchi has been continued by his co-workers and by numerous investigators in many countries. Today, seven years after the announcement of the discovery of Bact. granulosis, new publications on this organism are appearing, making the problem still active. There are now at one's disposal more than one hundred articles dealing with this subject, and one feels justified in attempting to analyze this material and to establish more definitely the place of Bact. granulosis in the etiology of trachoma. Before this is done a few remarks concerning Noguchi's original work and technic will be necessary.

1. Noguchi, with the assistance of competent ophthalmologists, selected five American Indians having trachoma of at least two years' duration with scarring. These patients were untreated, and their condition was diagnosed as type II in MacCallan's classification.

2. The material used was that from expressed trachoma follicles and excised strips of conjunctiva, including the underlying tarsus.

3. Noguchi used the material from expressed follicles to smear directly on culture material. He finely ground the excised strips of conjunctiva, suspended the substance in physiologic solution of sodium chloride and inoculated blood agar plates, semisolid leptospira mediums, avery plates and solid ascites agar plates. The cultures had a p_H of 7.8 and were kept at a temperature between 15 and 37 C. for a period of forty-eight hours.

4. All of these culture mediums were minutely studied for growths over a period of several weeks, and each colony was examined from a morphologic and a bacteriologic standpoint.

5. Each separate strain isolated and similar pooled strains were inoculated into the conjunctivae of monkeys.

By this extensive experimental work Noguchi was able to isolate a new organism with which he produced granular conjunctivitis in the conjunctivae of monkeys.

The organism had the following characteristics: It was a gram-negative, motile bacillus, with one flagellum. In young cultures the organism varied from 0.25 to 0.3 microns in one diameter and from 0.8 to 1.2 microns in the other. The colonies were scarce, small, clear and elevated, with a grayish cast. As the cultural characteristics were not sufficient to identify the organism, Noguchi depended for identification on the morphologic characteristics and on the fact that the organism produced granular conjunctivitis in monkeys.

In the experiments on monkeys Noguchi injected a saline suspension of his organism into the superior retrotarsal fold of the conjunctiva. Except in his first attempts, he scarified the conjunctiva into which the inoculation was made. The changes produced in the tissues were of a granular type of conjunctivitis; hence the name of the organism was to be "Bacterium granulosis."

Noguchi reisolated the organism from the monkeys that were successfully inoculated. He selected as the optimum time of isolation between the seventeenth and the one hundred and fifty-sixth day following the onset of granular conjunctivitis. He reinoculated twenty-five monkeys with the isolated organism and was successful in producing granular conjunctivitis in twenty-one.

At this time Noguchi reported that he was successful in producing four successive tissue passages with Bact. granulosis.

It is now readily understood why Noguchi believed at the conclusion of his work that he had fulfilled Koch's postulates with the new organism and had proved it to be the etiologic factor in trachoma.

In his experiments Noguchi used over one hundred monkeys. Some of these monkeys in which he produced granular conjunctivitis were later examined at the Rockefeller Institute by Wilmer, Knapp, de Schweinitz, Cohen, Verhoeff, Derby and Fuchs. These men expressed the opinion that the conjunctivitis produced in monkeys by the injection of Bact. granulosis resembled trachoma in human beings.

The first object of the investigators who endeavored to verify Noguchi's work was to isolate and identify the organism in trachomatous conjunctivae. This was no simple matter, as Noguchi himself had emphasized the peculiar difficulties encountered in obtaining the organism from trachomatous conjunctivae and in making it grow on culture mediums.

Many attempts were made to isolate the Bact. granulosis of Noguchi in laboratories throughout the world. Many difficulties have arisen in the technic required for isolation and identification. Weiss,[1] in his résumé and experimental work, stated that the infrequency of isolation of Bact. granulosis is probably due to three factors: (1) the difficulty in isolation and identification, (2) the rapid loss of virulence of Bact. granulosis in cultures and (3) the resistance of the common laboratory monkeys to the bacterium as well as to trachoma. He further confirmed the statements of other workers that the usual methods of identification are of little aid.

In further reports, Finnoff and Thygeson,[2] Fischer-Ascher,[3] Stepanova and Asarova [4] and Thygeson [5] stressed the difficulties of isolating and identifying Bact. granulosis. A further difficulty was pointed out when Nicolle and Lumbroso,[6] Cattaneo,[7] Bietti,[8] Morax and Nida,[9] Rohrschneider and Heymann,[10] MacCartney and Mayou,[11] Mayou [12] and Weiss [13] reported that Bact. granulosis rapidly loses its virulence in cultures.

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1. Weiss, C.: (*a*) Studies on Trachoma: Direct Transmission of Human Trachomatous Lesions to Various Animals, J. Immunol. **25**:247 (Sept.) 1933. (*b*) Weiss, C.; Reymond de Gentile, O., and Conseil, E.: Lésions conjonctivales, consecutives à l'inoculation de Bacterium granulosis (Noguchi), Arch. Inst. Pasteur de Tunis **19**:433 (Dec.) 1930. (*c*) Weiss, C.: Studies on Bacterium Granulosis in Relation to Trachoma: Pathogenicity for Various Monkeys and Apes, Proc. Soc. Exper. Biol. & Med. **28**:398 (Jan.) 1931.

2. Finnoff, W. C., and Thygeson, P.: (*a*) The Finding of Bacterium Granulosis (Noguchi) in Trachoma: Preliminary Report, Am. J. Ophth. **12**:651 (Aug.) 1929; (*b*) Bacterium Granulosis in Trachoma, Arch. Ophth. **5**:527 (April) 1931.

3. Fischer-Ascher, M.: Zur Aetiologie des Trachoms, Arch. f. Augenh. **104**: 441 (July) 1931.

4. Stepanova, G., and Asarova, N.: Zur Aetiologie des Trachoms, Allukraenisch. Kong. d. Augenärzte, Charkow **30**:12, 1929.

5. Thygeson, F.: Experimental Conjunctivitis in Monkeys Induced by Bacterium Granulosis, Am. J. Ophth. **15**:293 (April) 1932.

6. Nicolle, C., and Lumbroso, Ugo: Bacterium de Noguchi dans ses rapports avec l'étiologie du trachome, Compt. rend. Acad. d. sc. **192**:1173, 1931.

7. Cattaneo, D.: Osservazioni sull'etiologia del trachoma, Atti Cong. d. Ass. oftal. ital. Roma **22**:24, 1930.

8. Bietti, G.: Ricerca del "Bacterium granulosis" (Noguchi) ed osservazioni sul suo valore nella eziologia del tracoma, Boll. d'ocul. **9**:1171 (Oct.) 1930.

9. Morax, V., and Nidi: Recherches bactériologiques sur le trachome en Algérie, Rev. internat. du trachome **8**:133, 1931.

10. Rohrschneider, W., and Heymann, B.: Zur Frage der Trachomätiologie, Klin. Monatsbl. f. Augenh. **86**:400, 1931.

11. MacCartney, J. B., and Mayou, M. S., in Andrewes, C. H., et al.: A System of Bacteriology, London, His Majesty's Stationery Office, 1930, vol. 7, p. 244.

12. Mayou, M. S.: Deleted by author.

13. Weiss, C.: Present Knowledge of Etiology of Trachoma, J. Infect. Dis. **47**:107 (Aug.) 1930; footnote 1.

Noguchi [14] stated that Bact. granulosis was the only organism found that would produce granular conjunctivitis in monkeys. Finnoff and Thygeson [2a] and Tilden and Olitsky [15] later reported that they were unable to find the organism in any type of ocular disease except trachoma. However, Kanyó and Rötth [16] reported that they isolated Bact. granulosis from three cases of folliculosis and that the organism was agglutinated by immune rabbit serum.

The methods of obtaining material for culture as used by Thygeson,[17] Weiss [1a] and Olitsky and Tyler [18] were in general as follows: The trachomatous conjunctiva was scraped with a metal spatula and the follicles expressed or a strip of the conjunctiva and underlying tarsus which contained follicles was excised. The material was transferred to leptospira medium or to human blood agar plates by direct smear, or the medium was inoculated with the macerated material suspended in saline solution. From the ensuing growths, isolation of Bact. granulosis was attempted. To make the procedure less difficult, the Rockefeller Institute announced the discovery of an immune rabbit serum for agglutination purposes. Also they issued the warning that cocaine in a 5 per cent solution destroyed Bact. granulosis in five minutes.

The accepted criterion for identification of Bact. granulosis were: (1) its morphologic characteristics, (2) the production of granular conjunctivitis and (3) agglutination by an immune rabbit serum.

In the experimental work done following Noguchi's death the technic of the Rockefeller Institute was used by all workers with some modifications. Many of the workers in later experimental studies used cultures of Bact. granulosis provided by the Institute.

ISOLATION OF BACT. GRANULOSIS FROM CASES OF TRACHOMA

It is not surprising after considering the foregoing discussion that conflicting findings are reported. The isolation of the organism from cases of trachoma was the first experimental step, and the number of cases of successful isolation is recorded in table 1.

In this table are also recorded references to published reports from approximately sixteen different laboratories scattered throughout the

14. Noguchi, H.: The Etiology of Trachoma, J. Exper. Med. (supp. 2) **48**:1 (Aug.) 1928.

15. Tilden, E., and Olitsky, P. K.: Tr. Am. Acad. Ophth. **35**:225, 1930.

16. Kanyó, B., and Rötth, A.: Beiträge zur Kenntnis der Rolle des Bacterium granulosis in der Pathologie, Arch. f. Ophth. **129**:97, 1932.

17. Thygeson, P.: Inoculation of Human Conjunctiva with Trachomatous Materials, Am. J. Ophth. **16**:409 (May) 1933. Finnoff and Thygeson.[2b]

18. Olitsky, P. K., and Tyler, J. R.: Trachoma in Egypt, Arch. Ophth. **10**: 440 (Oct.) 1933.

world. The reports from foreign countries, with the exception of that of Fischer-Ascher [3] and of Stepanova and Asarova,[4] give a low percentage of successful isolations.

In this country the higher percentages of successful isolations have been reported by the co-workers of Noguchi at the Rockefeller Institute.[19] Weiss [20] and Finnoff and Thygeson [2] have also reported comparative percentages of isolations of Bact. granulosis. One notes a marked variation in the percentage of successful isolations, the figures ranging from 12 to 70 per cent. On examining the reports one finds very meager details given as to the technic followed by most of the workers. It is usually stated that the technic used was similar to that of the workers at the Rockefeller Institute. Whether or not agglutina-

TABLE 1.—*Reports on Isolation of Bacterium Granulosis from Cases of Trachoma*

Author	Year	Place	Number Studied	Number Isolated
Bordonaro: Boll. d. Soc. med.-chir., Pavia **43**: 755, 1929	1929	Italy	3	2
Olitsky and co-workers (footnotes 15, 18, 19a-d)	1929	United States		
	1933	Egypt	28	15
Finnoff and Thygeson [2]	1929, 1931	United States	20	10
Bietti [8]	1930	Italy	16	2
Kendall and Gifford: Arch. Ophth. **4**: 322, 1930	1930	United States	..	1
Weiss (footnotes 1a and c; 20a; 45)	1930	United States		
	1933	Tunis	41	30
Addario [39a]	1930	Italy	..	1
Tilden and Tyler [19c]	1930	United States	18	6
Reimann and Pillat [21]	1931	China	5	1
Fischer-Ascher [3]	1931	Praha	60	11
Stepanova and Azarova: Mikrobiol. J. **8**: 180, 1929	1931	Russia	10	7
Takamatsu: Acta soc. ophth. Jap. **35**: 797, 1931; abstr., Zentralbl. f. d. ges. Ophth. **26**: 469, 1932	1931	Japan	..	1
Kanyó and Rötth [16]	1932	Budapest	15	2
Berberov and Alekseev [42]	1932	Russia	..	1
Thygeson [5]	1932	United States	5	2
Tallo [32]	1932	Italy	..	1

tion reactions or experiments on monkeys were used is not mentioned except by about six of the authors. The morphologic characteristics were the only means of identification reported to have been used by many workers.

19. (*a*) Olitsky, P. K.; Knutti, R. E., and Tyler, J. R.: Transmission and Cultivation Experiments with Human Trachoma and Experimental Disease in Monkeys, J. Exper. Med. **54**:31 (July) 1931; (*b*) The Effect of Secondary Infections on Experimental Trachoma, ibid. **53**:753 (May) 1931; (*c*) Studies on the Filtrability of Bacterium Granulosis, ibid. **54**:557 (Oct.) 1931. (*d*) Olitsky, P. K., and Tyler, J. R.: Bacterium Granulosis and Trachoma of an Urban White Population, Science **71**:263 (March 7) 1930. (*e*) Tilden, E. B., and Tyler, J. R.; Bacterium Granulosis in Relation to Trachoma: Its Recovery from Experimentally Infected Monkeys and from Human Trachoma, J. Exper. Med. **52**:617 (Oct.) 1930. (*f*) Olitsky and Tyler.[18] Tilden and Olitsky.[15]

20. (*a*) Weiss, C.: Studies on Trachoma: Susceptibility of Rhesus Monkeys to Conjunctival Infection by Bact. Granulosis Under Various Experimental Conditions, J. Immunol. **25**:227 (Sept.) 1933. (*b*) Weiss (footnote 1*a* and *c*).

The inadequate information furnished to justify identification of Bact. granulosis prompted Thygeson,[17] Lindner [21] and others to state that they considered most of the work reported as unsubstantiated. Bengtson [22] was more specific in her criticism, stating that in her opinion only six of twenty-three investigators gave reasonable proof that they had isolated an organism similar to the Bact. granulosis of Noguchi. Bengtson [22] and Thygeson [17] suggested that most of the investigators could be credited only with the isolation of a Bact. granulosis-like organism rather than with the isolation of a true strain of Bact. granulosis.

In contrast, the smaller group of investigators who gave adequate proof of their isolation and identification of Bact. granulosis is headed by Olitsky [23] and his co-workers. Another able and careful investigator is Weiss,[24] who gave comprehensive and successful reports. In reference to the many reports in the foreign literature, it must be recorded that Tilden and Olitsky [15] examined the organism isolated by Addario and pronounced it to be a true strain of Bact. granulosis.

The difficulty of isolation due to the poor growth of Bact. granulosis on culture mediums was stressed by all workers, and the importance of repeated examinations was emphasized, as the organism was seldom found on the first attempt.

In table 2 are tabulated the names of investigators who were unsuccessful in their attempts to isolate and identify the Bact. granulosis of Noguchi in cases of trachoma. Among these investigators is Thygeson,[25] who, in his later work, concluded that the organism he discovered was only similar to the Bact. granulosis of Noguchi. Other men and women of unquestioned ability who are included in this group are Mayou,[12] Bengtson,[26] Wilson [27] and Morax [28] and others. Thygeson,[25b]

21. Lindner, K.: Ist das Bacterium granulosis Noguchi der Erreger des Trachoms? Arch. f. Ophth. **122**:391, 1929.

22. Bengtson, I. A.: Etiology of Trachoma with Reference to Relationship of Bact. Granulosis (Noguchi) to the Disease, Pub. Health Rep. **47**:1914 (Sept. 16) 1932.

23. Olitsky, P.: Trachoma in Man and in Apes, Arch. Ophth. **11**:730 (April) 1934. Olitsky, Knutti and Tyler.[19c]

24. Weiss.[20a]

25. Thygeson, P.: Bacterial Flora in Egyptian Trachoma, Am. J. Ophth. **14**: 1104 (Nov.) 1931; Recherches expérimentales sur le trachome, Arch. Inst. Pasteur de Tunis **22**:157 (Aug.) 1933.

26. (*a*) Bengtson, L. A.: Bacterium Granulosis Conjunctivitis Compared with That Produced from Human Trachoma, Pub. Health Rep. **47**:2281 (Dec. 9) 1932. (*b*) Bengtson.[24]

27. Wilson, R. P.: Discussion on Aetiology of Trachoma with Special Reference to Bacterium Granulosis (Noguchi), Brit. J. Ophth. **15**:433 (Aug.) 1931.

28. Morax, V.: Le bacterium granulosis et le trachome, Rev. internat. du trachome **7**:2, 1930.

in his later work in Tunis, in which he used a large series of cases, could not isolate Bact. granulosis.

EXPERIMENTS ON MONKEYS

After isolating an organism, one must use some medium to reproduce the disease in order to fulfil one of Koch's postulates. Noguchi [14] found that one means of identifying his organism was to determine whether or not it would produce granular conjunctivitis in monkeys. Monkeys, therefore, became the experimental animal chosen for the attempt to produce trachoma or a trachoma-like condition. Noguchi succeeded in producing four consecutive tissue passages and recoveries of his Bact. granulosis from the conjunctiva of a monkey.

TABLE 2.—*Reported Instances of Failure to Isolate Bact. Granulosis in Cases of Trachoma*

Author	Year	Place	Number Studied
Mayou [12]	1929	England	
Brückner: Oft. sbornik. **3**: 1, 1929	1929	Poland	
Sabata: Oft. sbornik. **3**: 267, 1929	1929		
Bengtson: Am. J. Ophth. **12**: 755, 1929 (footnote 22)	1929, 1932	United States	73
MacCartney and Mayou [11]	1930	England	
Morax [28]	1930	France	
Lawrynowitch and Melanowski: Proc. Internat. Ophth. Cong., Amsterdam **11**: 540, 1930	1930	Poland	
Favalaro: Atti Cong. d. Ass. oftal. ital. Roma **22**: 24, 1930	1930	Italy	
Tang: Nat. M. J. China **16**: 68, 1930	1930	China	
Lumbroso and Van Sant: Comp. rend. Acad. d. sc. **192**: 1140, 1931	1931	France	
Cattaneo: Studi Sassaresi **9**: 14, 1931	1931	Italy	
Rohrschnieder and Heymann [10]	1931	Germany	
Wilson [27]	1931	Cairo	16
Puscariu and Nitzulescu: Ann. di ottal. e clin. ocul. **60**: 393, 1932	1932	Rumania	70
Thygeson [25b]	1933	Tunis	63

In table 3 are tabulated the results of attempts of certain investigators to produce granular conjunctivitis in monkeys by the inoculation of Bact. granulosis or of a Bact. granulosis-like organism. The results vary from no conjunctivitis to 100 per cent production of conjunctivitis. The animals used principally were Macacus rhesus, while in a few cases Macacus sinicus, Macacus inuus and chimpanzees were used. In spite of certain disadvantages the monkeys were the most acceptable experimental animals. The conjunctivitis produced was of a granular type involving the retrotarsal folds and the tarsal area. The condition developed rapidly and often spread spontaneously to the other eye.

The typical technic employed was as follows: The culture material, a proved suspension of Bact. granulosis, was injected into the retrotarsal folds of the eye. In the successful cases some form of irritation was used with the injection. Bengtson [26a] used massage, and Noguchi [14]

used scarification, as did Olitsky and his co-workers.[29] Thygeson,[30] Reimann and Pillat [31] and Tallo [32] also used scarification. Weiss [1a] used powdered cement in his series of successful cases to produce irritation after inoculation. In many cases repeated injections were necessary to produce conjunctivitis, while in other cases conjunctivitis was not produced.

Noguchi,[14] in one series of experiments, produced granular conjunctivitis in twenty-one of twenty-five attempts. Finnoff and Thygeson [2b] produced granular conjunctivitis in thirteen attempts. Wilson,[27] in Cairo, failed to produce any reaction in thirteen attempts.

Bengtson [26a] succeeded in producing a reaction in five of fifteen attempts, but he did not believe that the transient conjunctivitis produced resembled trachoma.

TABLE 3.—*Reports on the Production of Granular Conjunctivitis in Monkeys with Bact. Granulosis*

Author	Year	Number of Animals	No. of Cases of Granular Conjunctivitis
Tyler: Science **70**:612, 1929	1929	2	2
Olitsky and co-workers (footnotes 19a and d)	1930, 1931	4	4
Wilson [27]	1931	13	0
Finnoff and Thygeson [2b]	1931	20	13 (all that lived)
Reimann and Pillat [31]	1931	5	2
Bengtson [26a]	1932	14	6
Thygeson [5]	1932	5	4
Proctor, Finnoff and Thygeson [30]	1932	..	0
Tallo [32]	1932	2	1
Weiss [1a]	1933	9	4

Very few reports indicated attempts to recover the organism or to make repeated tissue passages, although Olitsky, Weiss and Thygeson reported more than one tissue passage with Bact. granulosis.

Various cultures were used in the inoculation of monkeys. Thygeson [33] used his own strain of Bact. granulosis as well as one supplied by the Rockefeller Institute. Wilson [27] was unable to isolate a strain, so he used a strain supplied by the Rockefeller Institute. Tallo,[32] like Wilson, was forced to use a strain from the Rockefeller Institute, with which he succeeded in producing granular conjunctivitis. Thygeson [5]

29. Olitsky and co-workers (footnote 19*a* and *d*).

30. Proctor, F. I.; Finnoff, W. C., and Thygeson, P.: Negative Inoculation with Bacterium Granulosis, Am. J. Ophth. **15**:206 (March) 1932. Thygeson.[5]

31. Reimann, H. A., and Pillat, Arnold: Studies on the Etiology of Trachoma, J. Exper. Med. **53**:687 (May) 1931.

32. Tallo, F.: Richerche batteriologiche ed immunitarie sul valore del "Bacterium Granulosis" di Noguchi nella etiologia del tracoma, Boll. d. ist. sieroterap. milanese **11**:225, 1932.

33. Thygeson (footnotes 2*b* and 30).

emphasized the necessity of repeated attempts when trying to isolate the organism after a tissue passage.

Wilson,[27] in discussing his failures to produce conjunctivitis by inoculation of Bact. granulosis into thirteen monkeys, stated that he succeeded later in producing a transient granular follicular conjunctivitis with material from a case of human trachoma; also, that with material from a monkey with folliculosis, he induced conjunctivitis by direct transfer.

The use of monkeys was early recognized as unsatisfactory. It was known that monkeys were resistant to trachoma and that pannus had never been reported. Among investigators who have stressed this point are Nicolle,[34] Weiss,[20a] Hess and Römer,[35] Greeff, Frosch and Clausen [36] and Heymann.[37] Noguchi [14] stated that the conjunctiva of the monkey was resistant to his Bact. granulosis. In all the cases in which successful inoculation of monkeys was reported, no pannus was ever found. The opinion advanced was that the lack of an adenoid layer in the conjunctiva of the monkey was responsible for the failure to produce a trachomatous-like condition in which scarring and pannus are present.

Another disadvantage in the use of monkeys was the fact that in captivity they were subject to a spontaneous type of folliculosis which confused many investigators. Observations of the condition were made by Thygeson [5] and by Weiss,[1a] who stated that a trained observer could differentiate spontaneous folliculosis from that induced by inoculation with Bact. granulosis. They stated also that the spontaneous type was transient and did not involve the tarsal conjunctiva. Wilson [38] made a careful study of the spontaneous folliculosis in monkeys in Cairo. He divided the condition into two types: (1) a noninflammatory shotty type with small, hard, translucent elevations which did not break down and (2) an inflammatory type with mucoid discharge and large translucent soft follicles, which tended to break down and rupture, causing small hemorrhages. Neither of these conditions seem to involve the tarsal conjunctiva, thus differentiating them from conjunctivitis produced by Bact. granulosis. Thygeson [5] stated on microscopic examination of one of Wilson's sections from a case of inflammatory spontaneous folliculosis that the follicles closely simulated those of the Bact. granulosis type.

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34. Nicolle, C.: Etat de nos connaissances d'ordre expérimental sur le trachome, Bull. Inst. Pasteur **19**:881, 1922.

35. Hess, C., and Römer, P.: Uebertragunsversuche von Trachom auf Affen, Arch. f. Augenh. **55**:1, 1906.

36. Greeff, R.; Frosch, H., and Clausen, W.: Untersuchungen über die Entstehung und die Entwicklung des Trachoms, Arch. f. Augenh. **59**:203, 1908.

37. Heymann, B.: Trachom, in Kolle, W., and Wassermann, A.: Handbuch der pathogenen Mikroorganismen, ed. 2, Jena, Gustav Fischer, 1913, vol. 8, p. 623.

38. Wilson, R. P.: Third Annual Report of Giza Memorial Ophthalmic Laboratory, Cairo, Egypt, Schindler's Press, 1929.

Tilden and Olitsky [15] studied spontaneous folliculosis in the monkey and made eleven unsuccessful attempts to recover Bact. granulosis.

Disagreement soon arose concerning the desirability of monkeys as the proper medium for experimentation. After the aforementioned group of competent ophthalmologists had examined Noguchi's monkeys, Lindner [21] came to this country and, along with other investigators, examined these animals. On returning home he published a comprehensive report in 1929 in which he denied that these monkeys had other than follicular conjunctivitis. Incidentally, in this same report Lindner stated that two of Noguchi's five original Indians did not have proved trachoma.

Many investigators early advocated experiments on human beings owing to the confusion arising from the use of monkeys as the experimental animal.

EXPERIMENTS ON HUMAN BEINGS

In table 4 are listed the results of attempts to produce trachoma in human beings by inoculating them with Bact. granulosis.

Over twenty attempts have been recorded in the literature, and many are probably unrecorded. In this series of over twenty experiments the production of trachoma has been reported in only one instance. The case is that of Addario,[39] who stated that he used a culture of Bact. granulosis from the Rockefeller Institute, followed the technic of the workers at the Institute and produced trachoma. The patient was later examined by Proctor, who stated the condition resembled type III of MacCallan's classification.

Wilson,[27] in his report, pointed out that Lindner inoculated his own eyes with negative results.

Thygeson [40] reported that he knew of eighteen unsuccessful attempts to produce trachoma in human beings with Bact. granulosis, and added five failures of his own. He carefully described his technic, his own strain of Bact. granulosis and two strains from the Rockefeller Institute being used. He repeated his attempts several times in each case. In another report, Thygeson,[17a] after failing to induce trachoma in the conjunctivae of two human beings with Bact. granulosis, succeeded in transferring trachomatous material to the eye of a 15 year old boy and producing trachoma.

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39. Addario, C.: (*a*) L'etiologia del trachoma ed i nuovi criteri diagnostici, terapeutici e profilattici che ne derivano, Ann. di ottal. e clin. ocul. **58**:1074 (Dec.) 1930; (*b*) Sul valore etiologico del Bacterium granulosis di Noguchi; trachoma sperimentale, Rev. internat. du trachome **8**:14 (Jan.) 1931.

40. Thygeson, P.: Rôle of Bacterium Granulosis in Trachoma, Arch. Ophth. **10**:1 (July) 1933.

Howard [41] mentioned Weiss' failure in three experiments on human beings and added an unsuccessful attempt of his own. He further stated that after his failure to produce trachoma by inoculation with Bact. granulosis he used scrapings from a conjunctiva with trachoma (type III) and produced trachoma that proceeded to scarring and pannus despite treatment.

Berberov and Alekseev [42] used two children who were free from trachoma and, after repeated attempts, failed to induce conjunctivitis by inoculation with Bact. granulosis; his experiments included irritation as well as simultaneous inoculation with a yellow staphylococcus.

In the series of reported experiments on human beings, one case is recorded as being successful. Without discussing this case, it is logical to assume that the reported attempts were unsuccessful. Before the one reported success can be accepted, it must be confirmed by other workers and other experiments.

TABLE 4.—*Reports on Inoculation of the Human Conjunctiva with Bact. Granulosis*

Author	Year	Number of Cases	Number Successful
Weiss: J. Infect. Dis. **47**: 107, 1930	1930	3	0
Wilson [27]	1931	4	0
Addario [30]	1931	1	1
Proctor, Richards and co-workers: Am. J. Ophth. **14**: 318, 1931	1931	2	0
Lindner [21]	1931	1	0
Proctor, Finnoff and Thygeson [30]	1932	2	0
Berberov and Alekseev [42]	1932	2	0
Thygeson (footnotes 17, 25 and 44)	1933	7	0
Howard: Am. J. Ophth. **16**: 132, 1933	1933	1	0

COMMENT

The purpose of this paper was to give a résumé of the experimental work done with Bact. granulosis of Noguchi in an effort to prove or disprove it as the cause of trachoma.

If one admits that trachoma is a transmissible disease, as the majority of workers do, one must assume that the etiologic factor is a microorganism, a virus or both.

Since Noguchi announced the discovery of his Bact. granulosis, most workers have directed their efforts toward proving or disproving that this organism is the cause of trachoma. Another phase has been advanced recently by Pittaluga [43] and Thygeson [44] at the ophthalmologic

41. Howard, H. J.: Results of Recent Investigation in Trachoma, Am. J. Ophth. **16**:218 (March) 1933.

42. Berberov, R. G., and Alekseev, G. M.: Bedeutung des Bact. granulosis (Noguchi) in der Aetiologie des Trachoma, Sovet. vestnik oftal. **1**:368, 1932.

43. Pittaluga, G.: Etiology of Trachoma from a Microbiologic Standpoint, Arch. Ophth. **11**:727 (April) 1934.

44. Thygeson, P.: Microbic Etiology of Trachoma, Arch. Ophth. **11**:728 (April) 1934.

congress at Madrid. They advanced the theory that Bact. granulosis may have a symbiotic relationship in the production of trachoma.

It is unfortunate that little antibody formation occurs in the body to aid in the search, although Weiss [45] pointed out that Negroes who are resistant to trachoma show a high agglutination titer for Bact. granulosis.

CONCLUSIONS

In evaluating the mass of literature beginning with Noguchi's work, many difficulties are encountered.

Bact. granulosis is an organism morphologically and biologically unstable. It loses its virulence rapidly on cultivation and is very difficult to isolate and to grow. It causes little or no production of antibodies. These facts must be borne in mind in considering the following conclusions:

1. Noguchi succeeded in isolating a previously unidentified organism from cases of trachoma.

2. Experiments on animals proved that Bact. granulosis produced granular conjunctivitis in monkeys which is not identical with trachoma.

3. Experiments on the human conjunctiva with Bact. granulosis have as a whole been failures.

4. For the foregoing reasons Bact. granulosis alone in the present state of knowledge cannot be considered the cause of trachoma.

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45. Weiss, C.: Studies on Trachoma: The Agglutinability of Bact. Granulosis in Sera of Trachoma Patients, J. Immunol. **25**:259 (Sept.) 1933.

Obituaries

VICTOR MORAX
1866–1935

Dr. Victor Morax died on May 14, 1935, in Paris, at the age of 69. He was the leader of modern French ophthalmology and one of the leading ophthalmologists of the world. He was born in Switzerland near the Lake of Geneva, the son of a physician, and received his medical education in Paris, where he lived for the rest of his life. He early became acquainted with the workers in Pasteur's laboratory, where he found an opportunity to continue his studies in bacteriology. While visiting the Charcot Clinic he met Parinaud, who persuaded him to take up the study of ophthalmology; he then became Parinaud's assistant and was his associate up to the time of Parinaud's death in 1905. He passed the examinations for intern in 1889, when his friend and teacher Terrier procured for him the ophthalmic appointment in the Hôpital Bichat. He was nominated ophthalmologist of the hospitals of Paris in 1900, and the subject of his thesis was "Bacteriologic Studies in the Etiology of Acute Conjunctivitis and on Ocular Asepsis."

Morax succeeded Delens in the Hôpital Lariboisière in 1903. In the twenty-six succeeding years he built up a new ophthalmic department of forty-five beds, with modern installation and a complete laboratory to which he would often return in the late afternoon for further work. Many students were attracted to the ophthalmic service of the Hôpital Lariboisière, and the number of patients rose steadily. In 1928 he had to retire on account of the age limit, but he continued his scientific investigations in the Pasteur Institute.

He was particularly interested in the bacteriologic, clinical and operative phases of ophthalmology, and his many publications were on these subjects. His microbiologic researches probably were the most important. He succeeded in cultivating the bacillus of acute contagious conjunctivitis, first described by Weeks. He recognized the presence of the pneumococcus in acute conjunctivitis and was a codiscoverer of the diplobacillus in angular conjunctivitis which carries the name of Morax-Axenfeld. In 1901 he turned to the study of trachoma, and during a visit to Egypt he proved that acute trachoma was due to a mixed infection. He devoted much study to follicular conjunctivitis, which he divided into the following groups: (1) trachoma, (2) swimming pool conjunctivitis, (3) acute conjunctivitis with follicles (Beal), (4) chronic follicular conjunctivitis and (5) conjunctival folliculosis.

In cases of sympathetic ophthalmia he showed that enucleation must be done within two weeks after the injury to safeguard against sympathetic complications.

He was a dextrous operator and had remarkable composure and judgment; he was most interested in plastic surgery, autoplasty and repair after extensive wounds or after the extirpation of tumors. In 1919 he delivered the Bowman Lecture on "Plastic Operations in the Orbital Region," and became one of the honorary members of the Ophthalmological Society of the United Kingdom.

His textbook "Précis d'ophthalmologie" appeared in four editions and was distinguished by clearness and conciseness of the text. "Sémiologie oculaire" was his contribution to the "Encyclopédie d'ophthalmologie." In addition to many papers which appeared in the ophthalmic

VICTOR MORAX
1866-1935

journals, Morax wrote the following books: "Glaucome et glaucomateux;" "Pathologie oculaire" and "Le cancer de l'oeil et ses annexes." He edited the *Annales d'oculistique* for many years. A list of his publications in chronological order will be found in the July issue of *Annales d'oculistique*.

Victor Morax was a man of remarkable working power and industry, of great personal charm and of the strictest professional probity; his death is a great loss to his country and to ophthalmology.

ARNOLD KNAPP.

This obituary is based on one written by A. Magitot (Ann. d'ocul. **172**:529 [July] 1935).

JULES GONIN
1870-1935

On June 10, 1935, the ophthalmologic world lost its most outstanding member. The discoverer of the principle underlying the successful treatment of retinal detachment is no more with us. The world at large was not even aware that one of its great benefactors had come and gone.

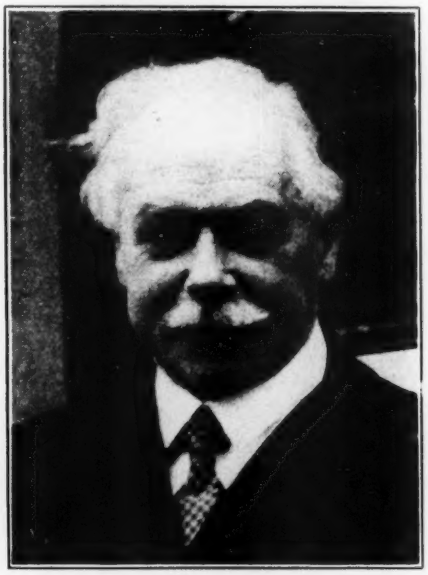
Jules Gonin was born on Aug. 10, 1870, in Lausanne, Switzerland. One hundred years before his birth his ancestors on his father's side emigrated from Piedmont on account of religious persecutions to settle in a more tolerant region, the canton of Vaud. His father was of French descent; his mother, German-Swiss. There was nothing in his youth that would have suggested in the least that Jules Gonin was the bearer of a distinguished destiny. He studied medicine at the University of Lausanne between 1888 and 1894. After his graduation he worked assiduously at the Institute of Pathologic Anatomy and then as intern at the Hôpital Ophtalmique de Lausanne under the direction of Prof. Mark Dufour. In 1903 he became privatdozent. Seventeen years later, after the death of Eperon, he was appointed chief surgeon of the hospital and professor of ophthalmology. Being of a studious nature, he learned several languages (Greek, Arabic and English), which encouraged him to travel extensively. He knew and loved his beautiful Switzerland. His great ambition and sport was to climb the most inaccessible glaciers. Little did he and the rest of the world guess that this Alpine climber was to scale the high peaks of fame and immortality.

The deciding moment of his career was when, still a medical student, he was allowed to substitute for the resident officer at l'Hôpital de l'Asile des Aveugles. The second date decisive for the future activities of this man was 1900, when he was invited by his chief and friend, Professor Dufour, to collaborate in rewriting the chapter on "Diseases of the Retina and Optic Nerve" for the "Encyclopédie française d'ophtalmologie." This task gave him the opportunity to study the literature of the subject and brought him face to face with the challenging problem of detachment of the retina. Between 1896 and 1919 he contributed to the ophthalmic literature about thirty papers on a variety of subjects (bacteriology of the conjunctiva, the fields of vision in retinitis pigmentosa, enucleation, etc.).

The training that Gonin received at the Institute of Pathology and careful study of Leber's teachings led him to the conviction that there is a causal relationship between tears in the retina and its detach-

ment. One can scarcely find in the history of medicine a more beautiful example of a theoretical conception of the pathogenesis of a disease leading to a therapeutic discovery of such outstanding importance.

In 1908 Gonin wrote a paper on retinal detachment. Ten years later, in a second paper, entitled "The Anatomical Causes of Retinal Detachments," he formulated clearly the results of his research work and observations. From then on, convinced that he was on the right track of solving the therapeutic part of the problem, he became its prisoner and valiantly stuck to what he had decided to be his important life work. In 1923 he published his first paper on the cure of retinal



JULES GONIN
1870-1935

detachment by the thermocautery method. Two years later he was invited by the French Ophthalmological Society to present his views at its meeting in 1925. The paper failed to arouse the interest of the members of the society. Neither was Gonin any more successful with a paper read before the Heidelberg Congress of the German Ophthalmological Society. It was not until 1929, at the Amsterdam International Congress, that the ophthalmologists began to listen to him with some degree of attention. Up to that time he had succeeded in obtaining a cure in twenty-two of thirty recent cases of retinal detachments and fifteen of thirty-five old cases. Those who heard his report marveled at such results. None of the members, even the oldest and most expe-

rienced, had ever seen more than a few isolated cures. Here was a man from a small clinic who had obtained cures in thirty-seven cases within a short span of a few years. It was evident that Professor Gonin's discovery was genuine and of the greatest importance.

One wonders how it is possible that ophthalmologists did not see the light when Gonin published his first paper six years previously. Does not psychology play an important rôle in the life of discoverers and the fate of their discoveries? For more than three quarters of a century numerous writers had been offering new theories and methods of treatment for retinal detachment. The universally accepted view was that detachment of the retina with a tear is the most incurable of the very rarely curable detachments. Professor Gonin's first announcement was less pretentious than that of his predecessors. In addition to this, and contrary to the consensus among ophthalmologists, he asserted that only a retinal detachment with a tear is curable by his method. Who could believe such a thing? But Gonin's results proved that he was right. This time the ophthalmologic world ascertained that some one had built a structure NOT of a substance brittle and perishable like those erected before Gonin's.

After the Amsterdam Congress there was nothing left for Professor Gonin to do but to wait and watch. He had written thirty-four papers on the subject in Swiss, French, Belgian, English and German journals. He had done his best to inform the medical profession about his work. Gradually, Lausanne became the Mecca of the ophthalmologic fraternity. I had the good fortune of visiting Professor Gonin in the summers of 1926 and 1928 at the l'Hôpital de l'Asile des Aveugles. On both occasions he showed the charm and kindness with which he was richly endowed. Postoperative cases were presented for examination; numerous excellent drawings of the preoperative picture of the fundus and several postoperative results were submitted; all sorts of questions were readily answered, "I don't know" being frequently and honestly repeated when experience could not support a definite statement. Finally, the operation was performed with patience, care and gentleness. One could never forget the man and the lesson.

"I am anxious that you Americans try out my method. Sometimes, recognition is easier in Europe when it arrives via America" were his words when I said good-bye to him.[1] But recognition came sooner than he expected. In 1929 the medical profession of Switzerland awarded him the Marcel Benoist Prize, and in 1934, on the occasion of his

1. The first Gonin operation in the United States was performed at the Knapp Memorial Eye Hospital of New York on Jan. 10, 1929.

visit to Glasgow, where he delivered the William Mackenzie Memorial lecture, the ophthalmologists of England pinned on his breast the Mackenzie Medal.

A few months ago appeared Professor Gonin's book recording his completed work. It appeared just in time—before nightfall.

Great discoveries take a good part of a lifetime of the most gifted. How slow the progress of our art! One great surgical discovery in ophthalmology in every seventy-five to a hundred years! Daviel—Graefe—Gonin!

MARK J. SCHOENBERG, M.D.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

HISTOLOGIC STUDY OF THE PIGMENTED EPITHELIUM OF THE IRIS AND CILIARY BODY IN EXPERIMENTAL DIABETES. G. VILLANI, Ann. di ottal. e clin. ocul. **62:** 763 (Sept.) 1934.

Villani produced hyperglycemia in rabbits by injecting from 5 to 12 Gm. of dextrose intraperitoneally daily or every few days for periods of from twelve to thirty-four days. The blood sugar reached a value of from 2.8 to 3.85 Gm. per thousand cubic centimeters. Several animals died; the others were put to death at various intervals. The pigmented epithelium of the iris and ciliary body was markedly swollen and edematous. In some cases the whole pigmented layer became necrotic and detached from the underlying tissue. Large vacuoles were seen between the cells. The unpigmented epithelium was always affected in the same way. The changes were produced in all five rabbits examined and, in general, were proportionate to the hyperglycemia produced. The relation of this to clinical changes seen in cases of diabetes is described. A bibliography is furnished.

S. R. GIFFORD.

REGION OF THE NORMAL LIMBUS IN SLIT-LAMP MICROSCOPY AND IN HISTOLOGIC PREPARATIONS. A. BUSACCA, Klin. Monatsbl. f. Augenh. **93:** 634 (Nov.) 1934.

Busacca studied the anatomy of the region of the limbus in photomicrographs taken with the slit lamp and compared his observations with those on histologic specimens which were made for this purpose. The article is very detailed and well illustrated with photomicrographs taken with the slit lamp and the microscope; two colored pictures are included. The technic and a series of observations are described, and the results are discussed and compared with those of other authors.

Busacca distinguishes two zones in the normal upper region of the limbus as seen with the slit lamp: the zone of the palisades and that of the terminal meshes. In some persons a narrow opalescent zone is observed distal from the terminating loops of the blood vessels; it pertains to the cornea. The zone of the palisades, aside from the palisades, is characterized by the presence of two vascular nets: one superficial, conjunctival; the other deeper, episcleral. The zone of the terminal meshes is characterized by a simple layer of vessels which corresponds with the episcleral vascular net of the globe, but which becomes more superficial through the normal rarefaction of the conjunctiva near the limbus.

Busacca's histologic examination proved that the appearance of this zone, resembling, as it does, palisades, is caused by elevations and ridges formed of connective tissue which are radially arranged. The elevated portion appears brighter, and the base of the epithelium brings the two

lines of the contour in evidence when inspected from a lateral point of view. In tangential sections papillae can be seen leading toward the limbus. The recurrent vessels run along the base of a papillar ridge, producing the appearance of a vessel in a sheath, if observed with the slit lamp, called the "vessels of the palisades" by Vogt.

K. L. STOLL.

Aqueous Humor

EXPERIMENTAL INVESTIGATION ON THE PRESENCE OF ARSPHENAMINE IN THE AQUEOUS HUMOR AFTER INTRAVENOUS INJECTION. TSUCHIYA, Acta soc. ophth. jap. **38**:106 (July) 1934.

The presence of arsenic in the aqueous after intravenous injection of arsphenamine has been the subject of repeated experimentation. Tsuchiya has made examinations for arsenic in the aqueous and in the cerebrospinal fluid after intravenous injection of arsphenamine, and found that one, two, four, eight, twenty-four and forty-eight hours after the injection there is no trace of arsenic in the first aqueous, but that it is definitely present in the second, or regenerated, aqueous. The amount found in the second aqueous depends on the concentration of arsenic in the blood. It is found only for a short time after the injection, and after forty-eight hours no more arsenic can be found either in the blood serum or in the aqueous.

A. KNAPP.

Conjunctiva

ACUTE PSEUDOMEMBRANOUS CONJUNCTIVITIS WITH BUCCOPHARYNGEAL ERUPTION AND WITHOUT DIPHTHERIA. M. BENOIT, Bull. Soc. d'opht. de Paris, December 1934, p. 616.

For about one month the patient had a bullous eruption on the surface of the pharynx. The general condition was poor with articular pains and fever. The eyelids were edematous. In the culdesacs and on the palpebral conjunctivae was a grayish membrane, easily detached and leaving no bleeding. The diphtheria bacillus was not found in smears from the pharynx or conjunctiva. All other tests including those for tuberculosis and syphilis were negative. The patient gradually began to lose the symptoms and signs of disease and after about six weeks was entirely well. The cause of the condition still remains a mystery, as all cultures were negative.

L. L. MAYER.

Congenital Anomalies

CONGENITAL COLOBOMA OF THE MACULA: TOGETHER WITH AN ACCOUNT OF THE FAMILIAL OCCURRENCE OF BILATERAL MACULAR COLOBOMA ASSOCIATED WITH APICAL DYSTROPHY OF HANDS AND FEET. ARNOLD SORSBY, Brit. J. Ophth. **19**: 65 (Feb.) 1935.

Sorsby gives a detailed history and description of lesions present in a mother and five children of a family consisting of the parents and seven children. It is impossible in an abstract to review the findings

in each of the affected persons, but the author's excellent summary supplies the essentials:

The literature on congenital macular coloboma is reviewed, and from the sifted material twenty cases of bilateral, thirty-six of unilateral and three (possibly five) of familial macular coloboma are considered. There is nothing in the ophthalmoscopic appearances of the lesion to stamp any particular defect as definitely congenital as opposed to those of postnatal origin.

Attention is drawn to cases in which macular coloboma was present with a typical choroidal coloboma in the same eye, also to cases in which macular coloboma was associated with other atypical colobomatous defects.

One suggestion which emerges is that nonpigmented colobomas tend to be deeply excavated, while in pigmented colobomas excavation is relatively less marked.

It appears that in addition to the recognized varieties of nonpigmented and pigmented macular coloboma, a third type, aptly described as a wheel figure, has a fairly characteristic appearance. In this type the center is white, and from it pigmented spokes radiate toward a pigmented rim.

Studies in the pathologic anatomy of macular coloboma, though none of them is conclusive, appear to indicate that there is no basis for the belief that congenital macular colobomas are the result of intrauterine inflammation.

A description is given of a familial group consisting of a mother and five children who showed bilateral pigmented macular coloboma. Associated with this defect was a rare skeletal abnormality known as apical dystrophy of the hands and feet. In one of the patients the condition of solitary kidney was present.

Attention is drawn to the studies of Landauer on the creeper fowl, a breed characterized by skeletal defects and ocular abnormalities. Consideration is also given to the work of Bagg and Little and their collaborators in experimental production of hereditary defects in mice, the defects involving the eyes, feet and kidneys.

Arguments are advanced in favor of regarding macular coloboma as a localized choroidermia.

There are two colored drawings and eight black and white reproductions of the fundus and ten plates showing the skeletal defects as revealed by x-rays.

An extensive bibliography is appended. W. ZENTMAYER.

ARACHNODACTYLIA OR MARFAN'S SYNDROME; FAMILIAL AND HEREDITARY OCULAR DEFECTS. H. VIALLEFONT and J. TEMPLE, Arch. d'opht. **51**: 536 (Aug.) 1934.

After referring to a family in which the father and three children suffered from bilateral congenital dislocation of the lens in association with arachnodactylia, Viallefont and Temple systematically review the published descriptions of this malformation, which was first reported in 1896 by Marfan under the designation of dolichostenomelia. Ocular defects which may be associated with it are dislocation of the lens, miosis, difficulty in pupillary dilatation and many other defects. Those

of the lens and the iris are the most common. Megalophthalmos, megalocornea, microphthalmos, defective vision, errors of refraction, paralysis of the muscles of accommodation and anomalies of the fundus have all been described. More rarely nystagmus, strabismus, vitreous opacities, edema of the lids and shortening of the lower lids have been described. An extensive bibliography is appended.

S. B. MARLOW.

INHERITANCE AND COMPLICATIONS OF CONGENITAL ANIRIDIA. K. NAKAO and K. YASUTAKE, Acta soc. ophth. jap. **39**: 15 (Feb.) 1935.

Congenital aniridia is generally associated with other anomalies and is directly inherited. This report gives a review of four cases with a study of the literature. The mother of one of the patients had the same anomaly. The parents in all four cases were not related. In all the cases there were visual disturbances consisting in corneal opacities, cataract, nystagmus, divergent strabismus and subluxation of the lens. The periphery of the cornea was stained by the gold chloride method, and in one case vision was improved from 0.002 to 0.008, and in another vision in the right eye was improved from 0.4 to 1.2, and that in the left eye from 0.5 to 1.2. The type of inheritance was studied from the literature. Aniridia and coloboma of the iris are not essentially different; they are only variations of the same process. Visual disturbances were present in 90 per cent of the cases and were due to cataract, refractive anomalies, nystagmus, hypesthesia of the cornea, lesions of the optic nerve, luxation of the lens and opacities of the cornea. It is striking that absence of the macula did not occur or was not noticed in a single case of the dominant type, while in cases of the nondominant type this condition was frequent (twelve times in forty-two eyes). Defects of the optic nerve were present in 50 per cent of the cases of the dominant type and in 19.2 per cent of those of the nondominant type.

A. KNAPP.

Cornea and Sclera

NUTRITIONAL XEROPHTHALMIA. J. A. THORSON, J. A. M. A. **103**: 1438 (Nov. 10) 1934.

A man aged 53 years, a farmer, white, unmarried, complained of failing vision for six years. He used no milk, cream or butter, and eggs only in the spring. Two years previously a diagnosis of keratoiritis with possible malacia had been made in another clinic. He was fairly well nourished. His hair and skin were dry.

In the right eye the cornea was dry, opaque and lusterless; the margin of the lid was swollen, and the lashes were covered by a dry greenish exudate. The conjunctiva of the lids and globe was congested. There was no pigment about the conjunctiva. The cornea was insensitive and vascular. There was a lace of capillaries encircling the cornea. Posterior synechiae were present. Vision was equal to counting fingers at 10 meters.

In the left eye the bulbar conjunctiva was thick and beef-red. The membrane was greatly swollen. There was a perforating corneal ulcer with a prolapse of Descemet's membrane. There was hypopyon. Vision equaled perception of hand movements at 1 foot (33 cm.).

Besides local treatment, typhoid vaccine was given intravenously. To the regular hospital diet, butter, milk, cereal and malt syrup containing 13,500 U. S. P. units of vitamin A per ounce were added.

When in about five weeks' time the patient left the hospital the conjunctiva of the right eye was normal. Much of the cornea was nebulous and vascular. The pupil was filled with pigment and old exudate. Vision was 6/30. In the left eye the condition was similar, and vision was 6/30.

Although hemeralopia is a frequent symptom in the ordinary mild chronic adult type of xerophthalmia it was not present at any time in this case. The disease ran a protracted course for six years, with a seasonal variation in severity. During the fall and winter months the patient consumed no vitamin A, while in the spring a few green vegetables and eggs became timely sight-savers. The effect of abundant sunlight, as proved by the ingenious experiments of Powers, Park and Simmonds, must also have been an important seasonal therapeutic factor. The article is illustrated.

W. ZENTMAYER.

KERATOGLOBUS AND INTERSTITIAL KERATITIS. P. BONNET and L. PAUFIQUE, Bull. Soc. d'opht. de Paris, March 1934, p. 232.

A 27 year old man gave a history of having had interstitial keratitis at the age of 7. Examination by the slit lamp showed a markedly thinned cornea, bilaterally, with the typical picture of keratoglobus. In addition, in the outer layers of the corneas were rests of old, grayish vessels. Both anterior chambers were large and deep. The Wassermann and Kahn tests were positive. The interest in seeing these two entities together is augmented by the statement of von Hippel, who believes that keratoglobus is due to congenital syphilis.

L. L. MAYER.

MARGINAL DEGENERATION OF THE CORNEA. J. M. HÖHR CASTAN, Arch. de oftal. hispano-am. **35:** 74 (Feb.) 1935.

This is the clinical report of a case of marginal degeneration of the cornea of the right eye in a man of 45 who when 12 years of age had suffered from a severe and long-lasting keratitis of traumatic origin The external aspect of the right eye was that of an ordinary arcus senilis but a biomicroscopic examination showed at this site a sulcus with deep infiltration of the underlying cornea. This was denser than usually occurs with gerontoxon, and the sulcus was formed at the expense of the outer corneal layers with destruction of Bowman's membrane and was covered with normal epithelium. The eye showed other degenerative stigmas in the shape of xanthelasma of both upper lids, several fatty islets in the tarsus and a pinguecula. The left eye was normal with a normal arcus senilis and no pinguecula.

The author reviews the literature and describes the disease at length, reproducing in connection with its pathology Fuchs' findings of destruction of the superficial corneal layers subjacent to the sulcus. He stresses the undetermined etiologic and pathogenic origin. He recommends correction of the resulting refractive error and either cauterization or Lauber's excision. Paracentesis and iridectomy do not seem to have been of benefit in the reported cases.

C. E. FINLAY.

RIBBON-SHAPED IMPREGNATION OF THE CORNEA WITH COPPER: REPORT OF TWO CASES. R. THIEL, Klin. Monatsbl. f. Augenh. **93:** 747 (Dec.) 1934.

Thiel reports two cases of ribbon-shaped opacities of the corneal epithelium and Bowman's membrane. With the slit lamp, fine foreign bodies could be seen, which had a metallic luster and were surrounded by a white area. No color phenomena were observed other than a finely striated yellow hue. The condition resembled that described by Schieck as ribbon-shaped traumatic corneal opacity on a chemical base. In location, form and color the corneal changes differed from those seen in other cases of exogenous chalkosis. No involvement of the corneal parenchyma was observed, such as that reported by Vogt in the case of a splinter of copper embedded in the parenchyma; Descemet's membrane was not discolored as described by Sallmann in cases of trachoma in which the eyes had received prolonged treatment with copper ointment.

K. L. STOLL.

KERATITIS PSORIATICA: REPORT OF A CASE. A. PILLAT, Klin. Monatsbl. f. Augenh. **93:** 751 (Dec.) 1934.

Only five cases of psoriasis of the cornea have been reported in ophthalmologic literature. Pillat enumerated in brief their main features. In these features the cases differ so greatly that doubts as to the actual causal connection between the keratitis and the eruption in the skin cannot be cleared up by them. Pillat adds the report of another case from which he draws the following conclusions:

Desquamation of the corneal epithelium such as occurs on the epidermis is prevented by the constant wiping action of the lids. The typical "greasy" appearance of the efflorescences of the skin is absent on the corneal efflorescences because the lacrimal fluid constantly moistens the parakeratoid tissues.

The cornea is rarely involved in a form resembling "phlyctenular keratitis"; there is no irritation present. The corneal efflorescences may occur on the limbus or centrally. The efflorescences on the limbus are raised and show a shallow defect resembling an abrasion; it is limited to the corneal epithelium and presents a serpiginous margin. The cornea is sensitive. Three portions of the efflorescence can be distinguished with the slit lamp: a process in the epithelium, a superficial opacification and a deep-seated opacification of the parenchyma. The keratitis appears and disappears simultaneously with the cutaneous eruptions. It may develop during the first attack of psoriasis, which happened in this case.

Local ocular treatment appears to be useless, but general therapy may yield results. Recurrences happen, but less frequently than with the dermal efflorescences. Both corneas, especially the lower portions, are usually involved; the area of the limbus is more frequently involved than the central portion of the cornea. The onset occurs in the subepithelial layers; the hyperkeratosis is caused by a chronic and slightly toxic process, beginning in the deeper tissues. The corneal psoriasis belongs in the class of the epidermal efflorescences but not in that of the efflorescences of the mucous lining.

K. L. STOLL.

KERATITIS, RESEMBLING KERATITIS BULLOSA, AFTER BILATERAL CATARACT EXTRACTION. J. G. LINDBERG, Klin. Monatsbl. f. Augenh. **93**: 781 (Dec.) 1934.

Only one case of keratitis bullosa after extraction of a cataract seems to be known. It was reported by Peters in 1908, prior to the use of the slit lamp. Lindberg reports the case of a woman, aged 75, who had cataracts extracted from both eyes; the operations were about three months apart and combined with an iridectomy. Large bullae developed on the cornea in the right eye five days after the operation, and on that in the left eye on the day following the operation. Recovery was obtained two months after each operation; opaque epithelial scars resulted. Examinations with the slit lamp were done fourteen and twelve days, respectively, after each operation. The epithelium was swollen and interspersed with dots resembling oil droplets or similar to superficial punctate keratitis. The parenchyma was practically free from pathologic changes. Numerous infiltrations were present in the endothelium and in Descemet's membrane, which was furrowed. Recovery and clearing took place quickest near the scar of the corneal incision. Pigment cells were distributed, especially near the endothelium.

To obtain better vision the opaque epithelium was scraped off nine months after the operation on the right eye and two months after that on the left. Vision of 5/7.5 was obtained in the left and of 5/15 in the right eye.

The scrapings were examined under the microscope. The most striking microscopic finding was the total absence of Bowman's membrane.

Lindberg concludes that the main changes occurred directly below the epithelium. Eczema of the epidermis or some individual disposition may have some connection with the pathologic process in the cornea. Therapeutic results may be obtained by scraping even after the lapse of several months. This therapy may be useful in other types of bullous keratitis and in herpes of the cornea.

K. L. STOLL.

CONSERVATIVE TREATMENT OF PTERYGIUM. G. A. DUCHAN, Sovet. vestnik oftal. **5**: 502, 1934.

A woman, aged 38, showed a heavily vascularized pterygium of the left eye, which had encroached on the cornea for a distance of 4 mm. The pterygium was excised four times but invariably recurred within a few months. Duchan then used weekly cauterization of the pterygium with a copper sulphate pencil along the limbus. The inflammatory reaction led to scarring with obliteration of the blood vessels. A 2 per cent solution of ethyl morphine hydrochloride was used by the patient at home. Since there has been no recurrence of the pterygium for a period of two years, the cure is considered permanent.

O. SITCHEVSKA.

Experimental Pathology

SYMPATHETIC OPHTHALMIA PROVOKED BY ULTRAVIOLET RADIATION IN AVITAMINOSIS A. G. MOURIQUAND, J. ROLLET and M. COURBIÈRES, Compt. rend. Soc. de biol. **118:** 1455, 1935.

In experimental avitaminosis A xerophthalmia supervenes at about the forty-fifth day, but with the slit lamp incipient lesions can be noted at about the thirtieth day. Moreover, latent corneal dystrophy is demonstrable a few days earlier by the diminished resistance of the eye to pathogenic agents. A light ultraviolet irradiation of a normal rat's eye causes a superficial burn that heals in from three to four days. In a rat on a deficiency diet, after the twenty-fourth day, such burns heal indolently and incompletely, and from four to ten days later the eye protected from the radiation begins to show congestive changes.

J. E. LEBENSOHN.

CLINICAL AND ANATOMICOPATHOLOGIC STUDY OF THE OCULAR MANIFESTATIONS OF EXPERIMENTAL AVIAN BERIBERI. E. MARCHESINI and M. PAPAGNO, Ann. di ottal. e clin. ocul. **63:** 81 (Feb.) 1935.

Twelve pigeons were fed on a diet free from vitamin B. Six died within from three to four weeks; the others were put to death when marked symptoms of avitaminosis developed. The ocular signs noted were, first, miosis, which was succeeded by mydriasis with absence of reaction to light, loss of sensitivity of the cornea and conjunctiva and loss of extra-ocular movements.

Histologically, the optic nerves and retinas were chiefly studied. The optic nerves showed marked granular and fatty degeneration of the myelin sheaths. This often affected the papillomacular bundle but extended through the whole nerve, being especially marked in the region of the optic chiasm and much less marked in the optic tracts. The axis-cylinders showed slighter grades of degeneration. The vessels were not affected, and there was no reactive hyperplasia of glia or infiltration with cells which would suggest an inflammatory process. The retinal changes were much slighter, being confined to slight degeneration of the ganglion cells and a relative lack of pigment migration between the rods and cones under the influence of light.

The findings agree with clinical findings in human beriberi, in which a retrobulbar neuritis affecting especially the papillomacular bundle is common.

S. R. GIFFORD.

METASTASES IN THE EYE PRODUCED BY KATO'S STRAIN OF RABBIT SARCOMA. NAKAYAMA, Acta soc. ophth. jap. **39:** 1 (Jan.) 1935.

Kato's strain of rabbit sarcoma was implanted subcutaneously in the backs of rabbits, and when the transplantations succeeded, the metastases in the eyes were studied. These occurred in 11.8 per cent and appeared usually in from thirty to seventy days after the subcutaneous transplantation. Metastases in the lungs were usually observed at the same time. The prognosis of the metastases in the eyes was generally unfavorable, as the rabbits with these metastases

generally died on an average of sixty days later. In 72 per cent of the cases the metastases were recognized during life. They usually appeared in the lower nasal and upper temporal parts of the iris and thus were easily observed. In the meantime the tumor in the back had grown to the size of a child's fist. The glands about the neck were enlarged. As has been previously stated, the metastases in the eyes were associated with metastases in the intestines and other abdominal organs. The intra-ocular metastases rarely appeared in the choroid, and then invaded the sclera and extended along the vortex veins. The extra-ocular metastases were situated in the vicinity of the optic nerve as well as in the adjoining nasal and temporal parts of the episclera. In some cases phthisis bulbi developed in the course of the metastases. Metastases were also observed in the orbit. There are 74 illustrations.

A. KNAPP.

EXPERIMENTAL INVESTIGATIONS ON THE INFLUENCE OF A CORNEAL TREPHINING ON THE INTRA-OCULAR TISSUES. S. NAKAYAMA, Acta soc. ophth. jap. **39:** 19 (Feb.) 1935.

If the intra-ocular pressure is reduced by escape of aqueous after a trephining of the cornea the intra-ocular blood vessels dilate and thereby the ciliary epithelium and the pigmented epithelial cells of the retina undergo increased activity. The hyperfunction of the ciliary epithelium is accompanied by a reduction of the p_H in the aqueous and vitreous and an increased passage of such drugs as sodium iodide, fluorescein and ferrocyanide. The hyperfunction of the pigmented epithelium of the retina increases the regeneration of the visual purple and the emigration of the pigment granules during dark adaptation. Following the sudden dilatation of the intra-ocular vessels blood serum exudes into the retinal tissue causing temporary edema of the retina. This transudation of material and increased synthesis of glycogen in the retinal tissue causes the glycogen content in the retina to be increased.

A. KNAPP.

General

CLINICAL SCIENCE AND OPHTHALMOLOGY. A. M. RAMSAY, Brit. M. J. **1:** 239 (Feb. 9) 1935.

Ramsay suggests that ophthalmology on account of its exactness and accuracy offers the nearest approach to laboratory training in clinical medicine. The subject is discussed under the heading of pain—inflammatory and noninflammatory. The knowledge of noninflammatory pain, or asthenopia as it was formerly called, was only obtained by the combined studies of the clinician and the physiologist, and the important lesson is drawn that research in a laboratory must always have the guidance of the clinician who seeks help. In considering disorders of the function of vision, attention is called to the clinical significance of a disturbed light sense. Disturbances in the receptor and conducting systems of the retina are shown by changes in the light minimum and light difference, subjects which have been explained only by the combined investigations of the clinician and the physiologist.

Ramsay has written a thought-inspiring article with the broadness and scientific point of view which always characterize his writings and repay the careful attention of the reader.

A. KNAPP.

General Diseases

RESEARCHES ON THE OCULAR COMPLICATIONS OF ICTEROHEMORRHAGIC SPIROCHETOSIS. S. RINALDI, Ann. di ottal. e clin. ocul. **62:** 737 (Sept.) 1934.

The literature on the ocular complications of Weil's disease is reviewed. In Rinaldi's case the diagnosis was confirmed by positive results from the injection of the patient's urine into guinea-pigs. In the fifth week of his illness the patient contracted an acute iritis of one eye. Vision was reduced to 1/60, but the condition cleared up rapidly, and the vision was normal after two weeks. The conjunctival secretion was injected into guinea-pigs, with the production of the disease and the recovery of spirochetes from the internal organs, which produced the disease on injection into other animals. Injection of the secretion into the vitreous chamber of a second guinea-pig caused death, although spirochetes were not found in the viscera. Other tissue fluids were injected into guinea-pigs, but positive results were obtained only with conjunctival secretion and blood at this stage. One animal receiving an injection of blood acquired a severe interstitial keratitis with hypopion. A bibliography is appended.

S. R. GIFFORD.

THE PROGNOSIS IN HYPERTONY BASED ON THE VASCULAR CHANGES IN THE FUNDUS. J. BRANA and P. RADNAI, Klin. Monatsbl. f. Augenh. **93:** 455 (Oct.) 1934.

Brana and Radnai discuss the present state of research on hypertony with reference to the vascular changes in the fundus. They stress the necessity of an individual rather than a class prognosis in hypertony. They recommend for this purpose that consideration be given to the degree of the hypertony and to the rates of the systolic and diastolic blood pressure. In this connection the opinions of other writers are cited, examinations with the capillaromicroscope are referred to, and the value of the terms "pale hypertony" and "red hypertony" is discussed. With the view of making the diagnosis by an evaluation of the fundus changes, the degree of the hypertony and the systolic and diastolic rates in each patient, the authors examined 100 patients with hypertony. A year later reexaminations were made of those who were still living.

The so-called sclerotic symptoms in the fundus received especial attention; they were divided into three grades: (1) those comprising slight variations in the width of the vessels, increased vascular reflex, distended and tortuous veins and pulsation at the disk; (2) those comprising more distinct variation in the width, narrowing of the arteries and often of the veins and decrease in the number of capillaries, producing pallor of the disk and the fundus, and (3) those comprising considerable contraction of the vessels, which are scarcer as a result of degenerative changes, and sometimes beginning optic atrophy and hemorrhages.

The compression of the veins at the crossings of the arteries is termed "Gunn's symptom" or "Salus' symptom" in the text and on some tables of this paper.

The following data were gained by comparison of the findings in the two examinations: 1. The height of the systolic and diastolic pres-

sure and the presence of albuminuria can be used only to a limited extent in the individual prognosis in cases of hypertony. The stability of the blood pressure, the degree of an eventual hyperglycemia and the result of a reaction after Wassermann cannot be used. Electrocardiographic examinations appear to be of value. 2. The study of the symptom groups of the changes in the fundus seems to be of greater value in establishing an individual prognosis: A mortality of 2 per cent was found in hypertony with slight fundus changes or none; the mortality was 60 per cent when the fundus changes were severe, and 100 per cent when they were very grave. 3. Hence, the individual prognosis is favorable in the first group, doubtful in the second and unfavorable in the third. 4. Only a slight connection exists between the degree of the vascular changes in the fundus and the height of the systolic and diastolic pressure; age plays no rôle in regard to the degree of the fundus changes. 5. Albuminuric hypertonic retinitis occurs only in the presence of severe changes of the vessels in the fundus. A large number of patients with hypertony who presented extensive changes in the vessels, but not necessarily retinitis died during the year of control. This experience prompts the authors to the view that the extent of the changes in the vessels is highly valuable in establishing an individual prognosis.

K. L. STOLL.

FUNDUS FINDINGS IN ACUTE POLYARTHRITIS. A. PILLAT, Wien. klin. Wchnschr. **48**: 302 (March 8) 1935.

In an examination of the fundi of twenty-eight patients with acute polyarthritis it was found that seventeen, or 60.7 per cent, had choroiditis. These were grouped as follows: (1) seven with discrete nodules, (2) six with grouped nodules, (3) two with fresh exudates and (4) two with disseminated miliary choroiditis.

For controls a group of normal persons within the same age limits were examined; only two of the twenty-eight showed a peripheral nodule in the choroid. In addition, twenty-eight patients with pulmonary tuberculosis were examined, and in only three with fibro-ulcerative tuberculosis were nodules found in the periphery of the choroid.

Considered as to cause were: syphilis, nontuberculous metastasis, metastatic tuberculosis and the possibility of an unknown cause.

Eleven of the seventeen patients with lesions of the fundus gave positive Löwenstein cultures of the tubercle bacillus. Pillat has not decided that the lesions were due to tuberculosis in spite of their characteristics and the positive blood cultures, but he emphasizes the importance of ophthalmoscopy in acute polyarthritis.

L. L. MAYER.

Glaucoma

USE OF A CALCIUM-MAGNESIUM COMBINATION IN LOWER CONCENTRATION IN CERTAIN CASES OF GLAUCOMA. JEAN GALLOIS and P. VIARD, Bull. Soc. d'opht. de Paris, July 1934, p. 406.

Gallois and Viard presented at the last meeting of the society a combination of 0.75 Gm. of calcium chloride with 0.8 Gm. of magnesium hyposulphite in 10 cc. of isotonic salt solution for use in reducing

the ocular tension in glaucoma. That report was abstracted in a previous issue of the ARCHIVES (13: 1090 [June] 1935). In the present article they cite three cases in which the original dilution of the combination had no influence on the tension whereas a dilution of the original to one-fifth strength reduced the tension from 65 to 50, from 40 to 26 and from 30 to 18, respectively, in the three cases. The authors' paper offering this modification is in the nature of a preliminary report.

L. L. MAYER.

Lacrimal Apparatus

EFFECT OF PERICAROTID SYMPATHECTOMY ON SALT ELIMINATION IN TEARS. D. MICHAIL, A. POP and A. CIPLEA, Comp. rend. Soc. de biol. **118:** 1499, 1935.

The cases studied were those in which pericarotid sympathectomy was done for atrophy of the optic nerve. For two days after the operation the salt content of the tears diminished to rise briskly on the third day, after which it tended to fall again.

J. E. LEBENSOHN.

DACRYOCYSTORHINOSTOMY AND ITS CLINICAL RESULTS. A. MOREU, Arch. de oftal. hispano-am. **35:** 127 (March) 1935.

Although a partisan of dacryocystorhinostomy, the author considers the extraordinary favorable results reported from this operation as greatly exaggerated.

In the treatment of dacryocystitis, he considers injections of a zinc sulphate, cocaine and epinephrine solution into the sac useful. Probing, stricturotomy and reestablishment of the duct he deems useless. Extirpation of the sac is indicated especially when dacryocystorhinostomy cannot be done. He considers dacryocystorhinostomy the operation of choice. A prior roentgen examination of anatomic conditions is required. The contraindications are nonphysiologic conditions of puncta and canaliculi, malposition of puncta preventing proper absorption of tears, adhesions in the interior of the sac, ozena, hypertrophy of the turbinated bones and deviation of the septum.

The author describes in detail his own method, which seems to be a variation of that of Dupuy-Dutemps and Basterra. He calls attention to possible complications and causes of failure.

C. E. FINLAY.

Lens

RESEARCHES ON THE QUESTION OF THE BACTERIAL ORIGIN OF HUMAN CATARACT. I. DE VECCHI, Ann. di ottal. e clin. ocul. **63:** 98 (Feb.) 1935.

De Vecchi repeated the experiments of Lavagna, who reported having produced cataract in guinea-pigs by injecting cataractous material into them and having grown a streptodiplococcus from his material. De Vecchi was unable to confirm Lavagna's findings in any respect. Cataract developed in none of his guinea-pigs, and cultures from cataractous lenses were negative.

S. R. GIFFORD.

DIABETIC CATARACT AND INSULIN THERAPY. R. BRAUN, Klin. Wchnschr. **14:** 222 (Feb. 16) 1935.

Braun shows that diabetic cataract is not necessarily the result of a shifting in the osmotic equilibrium between the lens and the aqueous humor of the eye, nor does he think that the acid intoxication of the organism in severe diabetes is the causal factor. He believes that other still unknown factors play a part and that the question of predisposition should be given attention. Large doses of insulin do not damage the lens. On the contrary, it has been demonstrated that under the influence of large doses of insulin advanced opacities of the lens may rapidly disappear.

J. A. M. A.

FURTHER EXPERIMENTAL DATA ON PATHOGENESIS OF CATARACT. N. K. MONYUKOVA and M. J. FRADKIN, Sovet. vestnik oftal. **6:** 29, 1935.

In this work the authors confirm the supposition expressed in their previous paper that disturbance of the permeability of the eye and of the capsule of the lens may lead to opacification of the lens. The pregnant guinea-pigs with transparent lenses were put on a scorbutogenous avitaminous diet (hay and oats) from four to eighteen days before delivery, with expectation of the formation of cataract in the next generation. The mothers and the new-born guinea-pigs died within a short time after birth. In the next series three pregnant guinea-pigs were fed alternately scorbutogenous and normal food. The four newborn offspring were examined with the slit lamp within from one to two days after their birth. They all showed a zone of punctate opacities in the posterior layer of the lens; in some lenses there were striated opacities in the superficial layers. Five guinea-pigs born from mothers fed on a normal diet showed no opacities in the lens. A control test was also done on chickens, which are considered to be nonsusceptible to avitaminosis C. A high content of vitamin C was found in the chicken's anterior chamber. Repeated puncture of the anterior chamber was done, but the lenses showed no opacities on examination with the slit lamp.

Monyukova and Fradkin come to the conclusion that cataract may appear as a result of a disturbance of the permeability of the eye on the general background of vitamin C insufficiency.

O. SITCHEVSKA.

RÔLE OF PARATHYROID GLANDS IN THE PATHOGENESIS OF CATARACTS IN YOUNG PERSONS. O. A. ROMANOVA-DUCHAN, Sovet. vestnik oftal. **6:** 67, 1935.

Romanova gives a thorough review and analysis of the literature on the relation between the function of the parathyroid glands and cataracts of senile and young persons. In order to verify the various opinions on this relationship, she examined a group of twenty-two patients suffering from cataracts and a control group who were free from lens opacities. The ages of all but four patients varied from 9 to 30 years. Eleven patients had zonular cataracts, and eleven, secondary membranes and soft ones after extraction.

The patients were examined carefully by neurologists for symptoms of latent tetany. The blood serum was examined for its content of calcium and of potassium. The evidence for tetany was considered positive if Chvostek's, Trousseau's or Erb's phenomenon was present. The blood calcium was determined by de Vaard's method and the blood potassium by the Cramer-Tysdale method. Since symptoms of tetany may be caused not only by a lowered level of calcium in the blood, but also by a change in the proportion of potassium to calcium, an increase in the index of the ratio of potassium to calcium was considered positive for tetany.

The average concentration of calcium in the blood of cataractous patients was 10.38 mg. per hundred cubic centimeters; that of potassium was 24.5 mg. In the control group the calcium was 11.06 mg. and the potassium 24.72 mg. per hundred cubic centimeters. A low level of calcium was found in six patients, or 27 per cent. Latent tetany was observed in six patients.

Thus the importance of hypofunction of the parathyroid glands in the pathogenesis of cataract in young persons was confirmed, as the symptoms of that condition were observed in about 50 per cent of the cataractous patients.

O. SITCHEVSKA.

Methods of Examination

AN IMPROVEMENT IN THE TECHNIC OF VOGT'S METHOD OF SKELETON-FREE RADIOGRAPHY OF THE BULB: CREATION OF AN EXOPHTHALMOS. M. KAELIN-SULZER, Brit. J. Ophth. **19:** 91 (Feb.) 1935.

The object of the modification of the technic of Vogt's method of skeleton-free roentgenography of the bulb is to overcome the limitation of the procedure to the most anterior portion of the eye. Exophthalmos is produced by injecting 3 cc. of a 1 per cent solution of procaine hydrochloride temporal and posterior to the globe. By this means the bulb is pushed a few millimeters forward. The case in which this technic was employed showed only one foreign body by the usual Vogt method, but by the procedure described a second particle similar in size to the first was plainly visible in the roentgenogram. The movements of the globe were reduced during the process of roentgenotherapy because of the absence of pain from the pressure produced by the film clasp and through the limitation of muscle action resulting from the injection.

The article is illustrated.

W. ZENTMAYER.

Neurology

MULTIPLE SCLEROSIS. C. A. VEASEY, Northwest Med. **34:** 60 (Feb.) 1935.

The patient was a boy aged 15. Two years previously the optic papillae showed temporal pallor. The visual fields were of the tubular type. For a period of two years there was recurring complaint of poor vision, which was relieved by suggestion and placebos. At the end of this period vision was reduced in each eye. There was horizontal nystagmus in the right eye. The optic papillae were more pallid than at the previous examination. The field of vision in the right eye showed complete reversal of the red and green fields. For the left eye there was

overlapping in about two thirds of the extent of the red and green fields. There was a temporal paracentral relative scotoma for green.

The neurologic examination showed evidence of multiple sclerosis, but a positive diagnosis was not made.

Veasey considers it unusual to find this condition so far advanced in eyes at the age of 13 to 15 years. The hysterical element must be given consideration.

W. ZENTMAYER.

DOUBLE CORTICAL INNERVATION OF THE MACULA AND PROJECTION OF THE CORTICAL VISUAL CENTER ON THE EXTERNAL GENICULATE BODY IN MAN: REPORT OF A CASE. A. JUBA, Klin. Monatsbl. f. Augenh. **93:** 595 (Nov.) 1934.

A former factory worker, aged 82, had been at a hospital for an unknown disease for seven weeks two years prior to his admission to von Blaskovics' hospital at Budapest. Vision had been failing for the same period of time, and bilateral intracapsular extraction with peripheral iridectomy was performed. Psychoneurotic restlessness required transfer of the patient to the psychiatric hospital three days later, and he died on the following day with symptoms of acute paranoia and heart failure. A detailed report of the postmortem examination is given and illustrated by photomicrographs. The observations are discussed and compared with the literature in point, with special consideration of the publications of von Lenz, Pfeifer and other writers. Extensive softening of the left occipital lobe had apparently existed for a long time but could not be exactly defined on account of the affliction of the eyes with cataracts. Every area of the cortical visual center was destroyed except the anterior portion of its upper margin. The fibers connecting the intact polar remnant of the area striata of the optic radiation were likewise degenerated. In the most medial portion of the left external geniculate body a conical area was spared. This area is considered as the zone of projection of the anterior portion of the upper margin of the calcarine fissure.

No changes of consequence were found in the right cortical visual center, optic radiation, Wernicke's field and optical tract. Nevertheless in the right geniculate body an atrophic zone was found which extended into the dorsocentral regions. From the pathologic observations the impression was gained that this atrophic zone in the macular area developed as a consequence of the destruction of the cortical visual fibers possessing double innervation or possibly collaterals. The von Lenz-Pfeifer theory of double cortical innervation of the macula seems to be sustained in this case. A degeneration of the superficial medullary sheaths in the left upper corpus quadrigeminum had developed following a lesion of the palliotectal tract.

K. L. STOLL.

Ocular Muscles

SOME NOTES ON THE TREATMENT OF STRABISMUS. S. R. GIFFORD, Brit. J. Ophth. **19:** 148 (March) 1935.

The object of the paper is to outline a routine of treatment which in the hands of Gifford and of the group working in his clinic has proved

very satisfactory. Some of the practical points to be culled from the article follow: In esotropia with less than 1 diopter of hyperopia bifocal lenses or grab fronts of 2 diopters plus may be of service when the eyes are straight for distance but show from 10 to 15 degrees of convergence when reading. In concomitant squint of all types and degrees, when refraction was done early, usually before the age of 6, with no other treatment than the use of atropine or occlusion, it was found that after six months the eyes were straight with glasses in 12.5 per cent of the cases, and after eighteen months, in 30 per cent. In divergent squint little is to be expected from correcting the refractive error, as a rule. Attempts should be made to improve amblyopia and fusion.

The results with amblyopia have been disappointing. With occlusion and the use of atropine the results have not been remarkable. Prolonged occlusion when vision is below 6/60 is as a rule impossible. The use of atropine and a system of reducing vision in the good eye are of value in overcoming suppression of the poorer eye and as an aid to orthoptic training, but actual improvement in vision has not been striking.

In accommodative squint fusion training seems to be of value in hastening a cure but is not always necessary.

Squints due to defective fusion include conditions in which vision is good and there is little or no refractive error, many divergent squints, especially those in which the divergence is intermittent or latent, and alternating squints. In the latter group, while fusing ability is undeveloped, it cannot be said to be absent.

In squint with amblyopia, when vision is less than 6/60 or 6/24, fusion training is of little value. Attempts should be made to improve the amblyopia, and the effect of glasses is watched for from six months to one year. After this time surgical intervention is indicated. Squint with anisometropia is considered a variety of this group. Iseikonic glasses may bring about binocular vision if it does not exist with ordinary lenses.

In squint due to muscular abnormalities surgical operation is indicated without preliminary training.

Dividing all types of squint into those of high and those of low degree, Guibor found in forty-eight patients that when the angle of squint was 15 degrees or less the eyes of 84 per cent became straight after refraction and orthoptic training, while when the angle was more than 15 degrees the eyes of only 16 per cent became straight.

The method of training is outlined. For overcoming suppression the large synoptophore of Maddox is ideal. The types of fusion charts are discussed.

Gifford believes that when progress is at a standstill operation should be advised regardless of age. Simultaneous operation on both lateral recti is adopted in nearly all cases of concomitant squint higher than 20 degrees. The eye with the poorer vision is selected. With advancement and recession, squint of 35 degrees and sometimes 45 degrees may be corrected by one operation. In the treatment of slight squint and phorias the O'Connor operation seems to have a definite place.

The article is illustrated.

W. ZENTMAYER.

OCULAR TORTICOLLIS OR SQUINT. E. TEMPLE SMITH, Brit. M. J. **1:** 416 (March 2) 1935.

In an article published in a previous issue of the *British Medical Journal* (**1:** 374 [March 3] 1934) an abstract of which appeared in the ARCHIVES, Smith advanced his hypothesis that when there is a weakness of the superior rectus with an overaction and hypertrophy of the complementary inferior oblique of the other eye the patient is confronted with two alternatives: If the refraction is normal he probably tilts his head to avoid diplopia, whereas if the refraction favors diplopia he squints and suppresses the offending image. Smith is impressed by the frequency with which overaction of the inferior oblique is conspicuous in cases of convergent squint and argues that convergence in these cases is simply protective. An operation to divide the oblique would be the correct procedure. This is borne out by the following case: A child 2 years of age had a left convergent squint of 40 degrees of three months' standing. Refraction showed a hypermetropia of 2.5 diopters in the right eye and of 5 diopters in the left. Glasses were prescribed and worn without influence on the squint. As the left inferior oblique was greatly overacting, a myotomy of this muscle was done, with removal of about ¼ inch (about 0.64 cm.). A week later the convergence had disappeared and has not returned. Smith believes that this operation should be done in all early cases; if the squint has existed so long that amblyopia is present the operation on the inferior oblique could not be expected to cure the squint, although the operation might be found desirable on other grounds.

A. KNAPP.

Operations

THE SLIDING FLAP METHOD OF TRUC. DELORD, COLIN and DEJEAN, Arch. d'opht. **51:** 763 (Dec.) 1934.

This operation was devised by Truc in 1895 for the correction of ectropion ex vacuo, senile ectropion and trachomatous entropion with trichiasis. The original procedure consisted in splitting the lids throughout their extent so that the anterior layer was made up of the skin and muscle, and the posterior layer, of tarsus and conjunctiva. Sutures were then placed so that the anterior layer slid forward in the case of ectropion; the posterior, in the case of entropion. Three modifications are described: The first consists in the grafting of the raw surface with skin in the case of ectropion ex vacuo; the second is the shortening of the lid in the case of senile ectropion, and the third, in the case of entropion with trichiasis, the covering of the raw surface of the tarsus with a pedunculated graft. The latter procedure is described in some detail. A number of cases in which operation was successful are briefly described. The authors believe that this procedure, a description of which does not appear in any textbook, is worthy of more general attention.

S. B. MARLOW.

ELECTIVE SURGICAL PARALYSIS OF INDIVIDUAL EXTRA-OCULAR MUSCLES. DEJEAN and KHAMINSKY, Arch. Soc. d. sc. méd. et biol. de Montpellier **15:** 514, 1934.

The levator and recti muscles are enclosed in their anterior thirds by a firm fibrous sheath through which it is difficult to inject anesthetic

solutions. The posterior two thirds of each of these muscles, however, is surrounded by a cellular covering through which the needle easily penetrates.

But more efficient than the direct injection into a muscle is the infiltration of its motor nerve. The ordinary retrobulbar injection has the disadvantage of producing a total ophthalmoplegia. Selective action is to be preferred in operations for strabismus; and in operating for detachment rotation is more easily maintained if the contractile tone of the opposing muscles is conserved.

In the technic recommended the muscles are all reached by penetrating the skin at the inferior external angle of the orbit and injecting not more than from 0.3 to 0.5 cc. of anesthetic solution. Using the superior attachment of the opposite auricle as the position of reference, one may infiltrate the nerves to the various muscles by pointing the needle as follows: (1) external rectus, 8 cm. posterior, 4 cm. above, and thrust 35 mm.; (2) internal rectus, 5 cm. posterior, 5 cm. above, and thrust 43 mm.; (3) inferior rectus, 6 cm. posterior, 1.5 cm. above, and thrust 40 mm.

To paralyze the superior rectus (a useful procedure in the operation for cataract) the needle is aimed at a point 4 cm. anterior to the opposite parietal boss, and the thrust is 35 mm.

J. E. LEBENSOHN.

CORNEAL TRANSPLANTATION. V. P. STRAKHOV, Sovet. vestnik oftal. 5: 454, 1934.

Fifteen corneal transplantations were performed in the Moscow Eye Clinic during the year 1933. Most of the subjects were young, and had total adherent leukoma; in some a small peripheral portion of transparent cornea was present. In all patients, the tension was normal, and projection of light was good. Twelve patients lost their vision in childhood; six of these from smallpox and measles. There were four transparent takings of the graft (20 per cent) and five semitransparent takings (40 per cent); in six the graft became opaque. Strakhov analyzes in detail the technic of the operation, the postoperative course and the complications. Filatov's prophylactic spatula traumatizes, in some cases, the anterior segment of the eye, as the underlying structure is not seen when the spatula is passed through the anterior chamber. The fixation of the transplant by the conjunctival flap after Filatov is considered ideal by Strakhov.

Opacification of the transplant usually begins at the end of the first week, and in the further course it either clears up or becomes more opaque. Vascularization begins within from two to four weeks after the operation. Patients with total leukomas are poor operative risks, as only in one patient, who had a simple leukoma, did vision improve. Strakhov therefore warns that one ought not to hold out too much hope to the blind until further improvement in the technic of keratoplasty has been achieved.

O. SITCHEVSKA.

Orbit, Eyeball and Accessory Sinuses

A Case of Inflammatory Pseudo-Tumor of the Orbit. T. Colley, Brit. J. Ophth. **19**: 93 (Feb.) 1935.

A boy, 13 years of age, had had the right eye and orbital contents removed the previous year by another surgeon because of a growth which the biopsy had shown to be of a chronic inflammatory nature. The pathologic examination showed a whitish mass almost cartilaginous in consistency surrounding the optic nerve. It was made up of inflammatory tissue only, suggestive of a syphilitic origin. Both Wassermann and sigma reactions were negative.

An increasing proptosis with downward and outward displacement of the left eyeball occurred. Below the inner part of the brow a nodular swelling could be seen. It gave the impression of a growth which was infiltrating the orbital tissues. The central retinal vein was obstructed. The Wassermann reaction was again negative. Exploratory incision was refused, as the parents believed that a similar operation on the other eye had aggravated the condition. Antisyphilitic treatment was given, and twenty months later the eye and orbit were normal.

The article contains a bibliography. W. Zentmayer.

Exenteration of the Orbit: The Conditions for a Good Exenteration; the External Prosthesis by the Pont Method. P. Bonn and A. Pont, Bull. Soc. d'opht. de Paris, March 1934, p. 218.

A young woman was operated on in 1923 for a melanotic tumor of the limbus. Recurrence of the tumor was noted later, but enucleation was refused. Finally the growth covered the entire cornea, nodules occurring throughout the conjunctiva of the bulb and lids. In 1933 an exenteration by means of electrocoagulation included the orbital periosteum, the sphenoid cells and the lacrimal sac. Plastic repair consisted in closing the margins of the wound by undermining the edges of the skin and attaching a prosthesis to the spectacles. L. L. Mayer.

Pharmacology

Sodium Evipan Anaesthesia in Ophthalmic Surgery, with Special Reference to Disadvantages. I. L. Johnstone, Brit. M. J. **1**: 761 (April 13) 1935.

Johnstone raises the question as to whether evipan (N-methyl-cyclohexenyl-methyl barbituric acid) will go the same way as sodium amytal did. In his opinion there is some value in evipan both as an anesthetic and as a therapeutic agent, but its disadvantages should be clearly defined. He objects to the article by Lyle and Fenton (Advantages of Intravenous [Evipan] Anaesthesia in Ophthalmic Surgery, *Brit. M. J.* **2**: 589, 1934) because they presented the subject from one side only and did not mention the disadvantages. The advantages are that the patient's face is free from an anesthetic mask, that the induction of anesthesia is rapid, and that recovery follows quickly. The disadvantages consist in undesirable reflexes, such as sneezing, coughing, twitching,

jerking and resistance. In two cases resistance was so active that ether had to be resorted to. In two cases postanesthetic nausea and vomiting were experienced and were as depressing as after inhalation anesthesia. As to the question of safety, evidence is accumulating to show that the use of evipan is attended with as great risk as that of any other anesthetic. Johnstone concludes that evipan in ophthalmic surgery has special disadvantages as well as advantages, and that in the small number of cases in which general anesthesia is necessary for ophthalmic work evipan is entitled to consideration.

A. KNAPP.

EVIPAN IN OPHTHALMIC SURGERY: FURTHER EXPERIENCES. T. K. LYLE and F. G. FENTON, Brit. M. J. **1:** 763 (April 13) 1935.

This is a continuation of an article on the same subject by these authors in a previous issue of the *British Medical Journal* (**2:** 589 [Sept. 29] 1934). They have performed over two hundred operations during a period of twelve months and their experience that N-methyl-cyclo-hexenyl-methyl barbituric acid is an ideal anesthetic for ophthalmic operations is confirmed. For general anesthesia this drug seems to them to be far superior from every point of view. In selected cases preoperative medication is practiced with injections of scopolamine hydrobromide and of a mixture of the hydrochlorides of the opium alkaloids and has proved very satisfactory. In a cataract extraction performed on an uncontrollable male patient N-methyl-cyclo-hexenyl-methyl barbituric acid was tried without any difficulties and with perfect satisfaction. The sneezing reflex seems to be caused by manipulation of the conjunctiva and is particularly noticeable when the conjunctiva is intensely inflamed, as in acute glaucoma. An interesting observation is the fall of intraocular tension under the influence of this anesthetic in cases of glaucoma. In such cases the drug has a definite advantage not only as an anesthetic before operation but as a possible therapeutic agent.

A. KNAPP.

Physiologic Optics

PHENOMENA CONNECTED WITH FUSION OF TWO IDENTICAL OBJECTS BY CONVERGENCE. R. GRIMM, Arch. f. Ophth. **133:** 121 (Nov.) 1934.

Grimm, ophthalmologist in Tientsin, China, is known for his papers on problems of physiologic optics. The present paper deals with the position of the fused image of two identical objects. The objects are located 30 cm. in front of the eyes and 10 cm. apart. Grimm fuses these two objects by convergence (without a stereoscope) and obtains a fused (binocular) image in the center and one monocular image on each side. He has been able to work out conditions under which the position of the fused image in the visual space of the observer can be determined. He finds that it lies at the crossing point of the optical directions (cardinal rays) belonging to the two objects. He modifies the details of this experiment by moving the two objects—*ceteris paribus*—toward one side and still finds that the fused image lies at the crossing point of the optical directions. Only excessive innervations (for instance, conjugate levoduction of 40 degrees plus the amount

of convergence necessary to fuse the objects set 40 degrees apart on the perimeter arc) move the fused image beyond the crossing point of the optical directions. In these and other similarly arranged experiments the influence of accommodation on absolute localization is eliminated. He comes to the conclusion that convergence—within its range of action—is the main factor which determines absolute (egocentric) localization.

P. C. KRONFELD.

Physiology

A CORRELATION BETWEEN PUPILLARY AREA AND RETINAL SENSIBILITY. M. LUCKIESH and F. K. Moss, Am. J. Ophth. **17:** 598 (July) 1934.

Luckiesh and Moss conclude that the variation in retinal sensibility between subjects is of the same order as the variation in areas of the natural pupils, and that human beings are poor judges of conditions best for seeing, their selection of best intensity of illumination being based largely on habit.

W. S. REESE.

Refraction and Accommodation

THE REFRACTIVE ERROR OF TWINS. F. W. LAW. Brit. J. Ophth. **19:** 99 (Feb.) 1935.

Law gives the refraction anomaly in eight pairs of presumably monozygotic twins. In order to be on the safe side he uses the less committal term "identical." The refraction anomaly in three pairs of dissimilar twins is given. Of the eight pairs, no less than four pairs were squinters, and one member of another pair had a slight error of convergence. He concludes from the admittedly small number of observations that: 1. Identical twins have by no means always identical refractions. 2. The refractions are alike in identical twins at least twice as often as they are in brothers and sisters born at different times. 3. Strabismus occurs oftener in twins than in siblings of different ages; it occurs sometimes in one member of the pair only, but far more commonly in both members, and then is of the same nature and direction in each.

W. ZENTMAYER.

Retina and Optic Nerve

RETINITIS IN DIABETES. H. P. WAGENER, P. H. DRY and R. M. WILDER, New England J. Med. **211:** 1131 (Dec. 20) 1934.

Wagener and his associates observed that of 1,052 patients having diabetes 17.7 per cent had hemorrhagic lesions of the retina, 5.5 per cent hemorrhage alone and 12.2 per cent hemorrhages associated with exudates. They believe that the very existence of retinitis in patients who have no other signs of vascular disease must mean that diabetes alone does something to injure the finer arterioles or venules of the retina. The retinal disease in question seems to pass progressively through successive stages, beginning with hemorrhages only and eventuating in very evident disease of the veins. The final stage is manifested by hemorrhage into the vitreous and the fully developed picture

of retinitis proliferans. Injury to the retinal vessels may occur in all cases of diabetes. If so, it is insufficient in degree in most cases to bring about visible abnormalities in the vessels or give rise to hemorrhages or exudates. In a few cases it does so, and it is more likely to be manifest when the circulation of the retina is adversely influenced by the presence of arterial or arteriolar sclerosis. In the latter case a lesion characteristic of diabetes is added to a retinal vascular lesion otherwise characteristic of hypertension; this gives a composite picture from which the trained observer can diagnose diabetes. Why diabetes injures the retinal vessels in this characteristic manner, whether because of its accompanying hyperglycemia or hypercholesteremia or because of the presence intermittently of the products of ketosis, the authors cannot say. The lesions are observed in cases of mild diabetes as frequently as in cases of severe diabetes, in those in which insulin is used as well as in those in which diabetes is controlled without insulin, early in the disease as well as late, although more frequently late, and when the carbohydrate of the diet has been unlimited as well as when it has been restricted and more fat has been fed. The possibility occurs to the authors that lesions like those observed in the retina may also occur in the peripheral nerves and thus account for the high incidence of peripheral neuritis among patients with retinitis.

J. A. M. A. (W. ZENTMAYER).

FAMILIAL MACULAR DEGENERATION. R. E. WRIGHT, Brit. J. Ophth. **19:** 160 (March) 1935.

After remarking that from time to time he had met with macular changes described as resembling "beaten brass or silver," some instances of which he has long considered as cases of familial degeneration, Wright describes a family group of six, two or whom were dead, in which three boys began to have very bad sight. A girl of 7 years had no trouble with her vision. The eldest living boy, aged 14 years, was first noticed to have defective vision three years before, and this had progressed. At the same time the second boy, then 9 years of age, was found to have poor sight. Later the youngest boy began to have failing vision.

In the first case the right eye showed a diffuse central retinitis, the whole macular region having an ill-defined appearance of varnished brass. The fovea was of a smoky or dull chestnut color. Around the macular area there was a fine pale mottling made up of irregular dentate spots. Toward the ora there were a few dark bluish patches. The disk was somewhat yellowish and pallid. The vessels were not contracted. Similar changes were present in the left eye.

In the second case the macular area had the appearance of beaten brass. Surrounding this as far as the equator, the fundus had a mosaic or marbling effect. The distribution seemed to have some relation to the vessels. The disk was yellowish but not atrophic. In both eyes the changes were similar.

In the third case the perimacular area showed fine mottling, much finer than in the other cases.

The chief features of note in this group of children with defective retinas were: the escape of the girl (only 7 years of age, however, when

first examined) and the associated progressive mental deterioration and dolichocephaly. When 8 years of age the girl still had nothing wrong with her vision, nor had the mother. The eyegrounds of the father, mother and girl were within normal limits. The girl, however, showed a concentric depression of the fields, the outline lying between the 10 and 20 degree circles, with a 3 mm. white object at 2 meters. (The mother's fields were much fuller extending beyond the 20 degree circle with a 2 mm. white object at 2 meters.) They showed two peaks at axes 45 and 135 in the inferior quadrant, the peak in the left inferior temporal quadrant being symmetrical with that in the right inferior temporal quadrant and reaching to the 40 degree circle in the form of a blunt cone. The inferior nasal peaks were similar, but reached only the 35 degree circle. The girl did not appear to have a narrow, elongated skull, and the father seemed to be square-headed, but the head of the mother was obviously of the long, narrow type. The actual conditions are shown in the reduced x-ray films and in the anthropometric figures. The girl's measurements are not very different from those of the youngest boy.

W. ZENTMAYER.

AN ARTERIOVENOUS ANEURYSM. BAILLIART and LAIGNIER, Bull. Soc. d'opht. de Paris, December 1934, p. 617.

When the patient was seen in May 1931 complaining of poor vision a diagnosis of thrombosis of the temporal vein of the retina of the right eye was made. The visual acuity was 1/30 and the arterial tension from 35 to 40. Later many anastomoses between the inferior temporal artery and the inferior temporal vein were noted. Gradually the superior temporal vein was distended at the point of thrombosis, and a large aneurysm formed one-fourth the size of the disk and elevated 3 diopters into the vitreous. The vein became arterialized. A photograph of the fundus is shown.

L. L. MAYER.

A CASE OF FUNDUS ALBESCENS PUNCTATA WITH CONSIDERATIONS AS TO THE RELATION OF THIS CONDITION TO OGUCHI'S DISEASE. D. GIANNINI, Ann. di ottal. e clin. ocul. **62:** 752 (Sept.) 1934.

Giannini refers to a case previously reported by him which was apparently the first case of Oguchi's disease observed outside of Japan. It concerned a woman of 29 with hemeralopia since the age of 17. Vision was 10/10 with each eye. The fundi showed numerous glistening white deposits, and the whole background gave a gray-white reflex. The vessels and disk were normal. In the extreme periphery were a few fine pigmented granules. The important thing in this case was a positive Mizuo phenomenon. After one hour and fifteen minutes in the dark the gray-white reflex of the fundus was replaced by a normal red color and the white deposits were invisible. The light sense and adaptation were markedly reduced. Examination of the family revealed one brother with a circle of white deposits about the disk but no hemeralopia or other changes in visual function.

His second case was that of a man 20 years old with hemeralopia since the age of 9. Central vision was normal, and the visual fields,

while normal in bright light, were markedly reduced in reduced illumination. The fundus showed numerous white deposits around the disk and in the macular region, in both eyes. The vessels and disks were normal. There were no other cases found in the family. The Wassermann reaction was weakly positive, and there were some stigmas suggestive of congenital syphilis, which were absent in the first case.

The literature on retinitis punctata albescens is reviewed, and the question is discussed whether the condition is identical with Oguchi's disease.

Giannini is inclined to think that with more numerous examinations made to detect Mizuo's phenomenon it would be found more often outside the Japanese race. He suspects that there are closer relations than have been observed between Oguchi's disease and retinitis punctata albescens.

S. R. GIFFORD.

OPTIC NEURITIS AFTER IMMUNIZATION AGAINST RABIES. HASABE, Acta soc. ophth. jap. **38:** 102 (July) 1934.

Hasabe draws attention to the unpleasant side effects of immunization against rabies, consisting in paraplegia of the legs with paralysis of the bladder and rectum and occasionally ascending paralysis. Cases in which the eyes also are involved are unusual. He has recently observed a case of bilateral optic neuritis following immunization against rabies. A boy 10 years of age was bitten by a mad dog in August 1933. The modified Pasteur injection treatment was given, and fever, paresis of the legs, hyperesthesia of the skin, headache and general prostration followed. Seven days after the completion of the treatment the patient suddenly complained that vision in the right eye was affected. On examination, optic neuritis was found in both eyes. The pupil of the right eye was immobile. Repeated lumbar punctures had a most favorable influence on the ocular symptoms.

A. KNAPP.

RETINITIS WITH NUMEROUS WHITE DOTS, PROBABLY TUBERCULOUS. KIKKAWA, Acta soc. ophth. jap. **38:** 153 (Dec.) 1934.

Under the name of retinitis tuberculosa several cases of retinitis have been described which are characterized by the presence of numerous white dots in the involved tissue. Kikkawa examined a condition of this kind in a woman 28 years of age who had complained of diminution of vision in the right eye for ten days. She was of a delicate structure, and an x-ray film of the chest showed some suspicious lesions. The visual field showed a small central scotoma with an enlarged blindspot. A cutaneous tuberculin test was positive; all the other tests were negative. The ophthalmoscope revealed a porcelain-like glistening swollen disk, with numerous areas of exudation, which extended into the retina upward. As the condition was regarded as tuberculous, specific treatment with albumose-free tuberculin was instituted. After two weeks the swelling of the disk had diminished, but many white spots had appeared in the nasal part of the retina. These seemed to be situated deep in the retinal tissue, underneath the retinal vessels. An imperfect star-shaped figure was observed in the macula. After a number of days these spots began to absorb. With a continuation of the treat-

ment with tuberculin there was rapid improvement; all the fundus changes in the retina and macula had disappeared after five months, and, notwithstanding the optic atrophy, vision was improved to 0.5.

A. KNAPP.

Trachoma

INTRA-CORNEAL INJECTIONS OF CYANIDE OF MERCURY IN TRACHOMATOUS PANNUS. E. S. SHALOM, Brit. J. Ophth. **19:** 107 (Feb.) 1935.

In twenty-five cases, severe trachomatous pannus that was rebellious to other therapy was treated with intracorneal injections of mercuric cyanide (1:1,000). Within from fifteen to twenty days the corneas improved definitely. In 20 per cent of the cases recurrences occurred after a few months. While this method of combating pannus rebellious to other treatment does not cure radically, it is safe, simple, painless and inexpensive.

W. ZENTMAYER.

Tumors

CORNEAL ANESTHESIA IN TUMORS OF THE CHOROID. J. SÉDAN, Bull. Soc. d'opht. de Paris, December 1934, p. 620.

For three years Sédan has watched a patient who had a melanotic sarcoma of the ciliary body, since enucleated, in whom there was an incomplete and limited anesthesia of the cornea in its external half corresponding to the site of the lesion.

In a second case the anesthesia was also incomplete; the zone occupied the superior portion of the cornea from 9 to 3 o'clock while the sarcoma in the ciliary region was from 11 to 2 o'clock.

A third patient seen with Ourgaud and Morenon had a ciliary sarcoma with iridodialysis and hemianesthesia of the right cornea.

Search of the literature fails to reveal any account of similar observations. The explanation may be that the pressure which destroys the nerves issuing from the posterior ciliary fibers constricts the nerves in the suprachoroidal space between the sclera and the choroid. Intraocular rise in pressure also may play a part, as all the cases presented the picture of glaucoma. Sédan believes that the sign may be useful in differentiating an ordinary retinal detachment from one due to tumor formation in the very early stages.

L. L. MAYER.

MELANOTIC SARCOMA OF THE CHOROID WITH IRIDODIALYSIS, HYPOTONY AND HEMIANESTHESIA OF THE CORNEA. J. SÉDAN, G. OURGAUD and J. MORENON, Bull. Soc. d'opht. de Paris, December 1934, p. 623.

In a man of 25 years a melanotic sarcoma of the choroid evolved with a minimum of symptoms. The outstanding features were: the iridodialysis, which was the first symptom; the absolute conservation of visual acuity in spite of the size of the tumor; the conservation of normal tension, which was changed to hypotony some days before intervention, and finally the anesthesia of the cornea.

When first seen the patient complained of a scotoma to the nasal side of the right visual field. There was a small detachment of the retina

in the temporal region between 7 and 9 o'clock near the ora serrata. The iridodialysis was inferior between 6 and 8 o'clock. The retina at the site of the detachment was brown. The visual acuity and the intraocular tension were normal. Tonometry without cocaine was permitted because of the hemianesthesia of the cornea. Transillumination was interfered with to such an extent that enucleation was advised and finally accepted. A histopathologic description of the tumor is given.

L. L. MAYER.

EXOPHTHALMOS AND CHOKED DISK PRODUCED BY TUMORS OF THE BONE. TAKANO, Acta soc. ophth. jap. **39:** 10 (Jan.) 1935.

A woman 57 years of age suffered from neuralgia of the right side for five months; two months later the left eye protruded, and there was gradual diminution of vision in this eye. On examination tumors as large as walnuts, soft and movable, were found in the frontal, parietal and temporal bones. Tumors were also found in the left side of the neck, in the left axilla and on the surface of the left side of the thorax. All tests were negative. The left eye showed a swollen upper lid with marked ptosis. The eye was prominent and its motility restricted upward and outward. Choked disk was present. Within the upper orbital margin a tumor could be palpated, which was not adherent to the eyeball. Roentgen examination of the skull and chest showed tumors in the skull and thorax, and the bone was found thinned and transparent. The condition gradually became worse, optic neuritis advanced, and vision was finally reduced to perception of hand movements. The tumor in the left orbit was removed together with the eyeball. Microscopic examination revealed the growth to be a myeloma. The changes in the eye were entirely secondary to the pressure on the optic nerve. Subsequently tumors appeared in the abdominal wall, the lymphatic glands all over the body became involved, and a spontaneous fracture of the clavicle took place. The patient gradually failed in health and died after eleven months of illness. The final diagnosis was multiple myeloma.

A. KNAPP.

Therapeutics

LYSOZYMES IN THE THERAPY OF INFECTIONS OF THE EYE. M. FRADKIN, L. S. LEVINA, N. N. BEKETOVSKIY, Z. V. ERMOLEVA, I. S. BUYANOVSKAYA and G. M. MAYRANOVSKIY, Sovet. vestnik oftal. **6:** 383, 1935.

A detailed description of the physicochemicobiologic properties of lysozyme is given by Fradkin and his collaborators. Fifty patients were treated with corneal applications of tampons soaked in lysozyme. Of these, twenty-one suffered from hypopyon keratitis, four from corneal ulcers in absolute glaucoma, and the others from postoperative infections and corneal ulcers of various origins. In thirty patients the clearing of the ulcers and the disappearance of the hypopyon were observed on about the fourth day after the treatment had begun. In one of these patients the hypopyon and the pain disappeared within six hours. In one case of traumatic iridocyclitis with hypopyon and thick exudate on

the iris lysozyme was injected into the anterior chamber, after the foreign body was extracted with a magnet. The hypopyon disappeared on the following day, the iris cleared, and on the fourth day the eye was nearly quiet, with the vision improved to 0.4.

The authors believe that lysozyme is not only a powerful bactericide, but that it also has a stimulating action on the tissues. It is most active in recent infections with disintegration of the tissue, as it has a free access to the site of infection.

O. SITCHEVSKA.

Society Transactions

EDITED BY DR. JOHN HERBERT WAITE

COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Jan. 24, 1935

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ALEXANDER G. FEWELL, M.D., *Clerk*

HISTORY OF THE OPERATIVE TREATMENT OF DETACHMENT OF THE RETINA. DR. WILLIAM ZENTMAYER.

The germ of all the present procedures for surgical reattachment of the retina may be found in the early literature of ophthalmology. As early as 1857 von Graefe punctured the retina, and in 1860 Kittle introduced scleral puncture. Wolfe later increased the puncture to an incision from 8 to 12 mm. long. In 1889 Schöler injected tincture of iodine into the preretinal space, that is, between the retina and the vitreous. In 1893 Schöler and Abadie independently sought by electrolysis to stimulate intra-ocular metabolism and thus cause absorption of the subretinal fluid and at the same time a reactive chorioretinitis. In 1877 M'Keown excised a piece of the sclera, and in 1879 Higgins employed a trephine for this purpose. In 1888 Gaupillar performed superficial cauterization. In 1895 Deutschmann introduced his much used procedure of retinovitreous transfixion, and later also employed injection of the vitreous of rabbits into the human vitreous chamber. In 1903 Müller introduced the removal of an elliptic section of the sclera from the lateral wall of the eyeball and closing of the wound by a number of horizontally placed sutures. He considered the special indication for this operation to be a high myopia in the presence of a detachment of long standing and usually total. Török and Heed have reported on the same operation. In 1910 Bettremieux introduced the removal of the superficial layers of the sclera tangential to the upper limbus of the cornea over an area 2 by 10 mm. The principle underlying this was that of aiding the return of the blood from the eye by securing anastomosis between the deep-lying vessels of the sclera and those of the conjunctiva.

In 1917 Verhoeff employed electrolysis, introducing a cathode into the eye and placing the anode on the cheek. He used a large number of small half-curved needles, which were passed through the conjunctiva and the coats of the eyeball until their tips appeared in the vitreous chamber. In 1919 Gonin began to use perforating thermocauterization, and in 1930 he published the results in 250 cases, stating that definite

cures can be obtained in about 60 per cent of recent cases, and that the percentage of cures decreases with the age of the detachments. In 1930 Guist laid down a number of trephine holes to demarcate the separated from the attached portion of the retina by a cicatricial band, the thin remaining layer of the sclera being scraped away and the choroid touched through each of the holes with potassium hydrate. In the same year Larsson and Weve developed a new method of diathermy in which a small negative electrode was applied to the sclera, the positive electrode being applied to some other part of the body. The object was to produce an adhesive coagulation that would reattach the retina. Weve later perfected a micropuncture method of electrolysis. Šafář modified the diathermic procedure by using small tacks, either singly or in groups. These were laid down in a curved line about the tear, employing a milliamperage sufficient to permit the needle to be implanted in the tissues by gentle pressure. The subretinal fluid was allowed to drain off, usually through a perforation made by a larger tack. In 1934 Vogt returned to the method of Verhoeff, introducing a cathode needle into the vitreous and placing the anode on the eyeball. A needle such as is employed in removing cilia by electrolysis is used. Dozens of momentary perforations can be made without damage. It differs from the Verhoeff procedure principally in that an attempt is made to place the punctures about the tear in the retina, when this is found. In 1934 Langdon reported the use of the thermophore in a case of retinal detachment, with a successful result.

MICROSCOPIC PATHOLOGY OF RETINAL DETACHMENT. DR. PERCE DE LONG.

De Long feels that the fundamental causes of retinal detachments are pathologic and dependent on some chemical change in the cellular metabolism. Reports of improvement in vision and increase of the visual field after operative intervention have in many cases been confirmed. The pathologic observations, although extremely meager, have not been equally convincing.

From studies and statistics it is known that traumatic detachment of the retina is more amenable than nontraumatic detachment to both medication and surgical treatment. It should always be remembered that retinal detachment is the expression of an irritation, whether it is caused by trauma, solar light, electricity, toxin or metabolic change, or whether it is the result of an insidious inflammation, a chronic disturbance or vascular changes. Cauterization of the choroid and retina with reattachment of the retina may temporarily alleviate the symptoms, but not in every case does it remove the cause and cure the disease.

THE REATTACHED RETINA: PHYSIOLOGIC, OPHTHALMOSCOPIC AND MICROSCOPIC OBSERVATIONS AND COMPARISONS. DR. EDMUND B. SPAETH.

This article will be published in full in a subsequent issue of the ARCHIVES.

February 21, 1935

J. MILTON GRISCOM, M.D., *Chairman*

A. G. FEWELL, M.D., *Clerk*

CONVERGENT CONCOMITANT SQUINT OF PARALYTIC ORIGIN. DR. WARREN S. REESE.

This case illustrates the fact that a concomitant squint may result from a muscle palsy. The patient first appeared at the Pennsylvania Hospital in October 1931, at which time external ocular examination gave negative results. In February 1932 he returned, complaining of double vision. This was explained by a paralysis of the right externus, which was unable to abduct the eye beyond the midline. During the next several months abduction gradually improved, but the squint remained, and now there is a 20 degree convergent squint of the right eye. On right lateral rotation he fixes with the right eye, and on left lateral rotation, with the left eye, fixation changing about 15 degrees beyond the midline. The ocular movements in all directions are good. His subjective tests are unsatisfactory, as he does not understand English well. Vision is 6/6 in the right eye and 6/6 plus in the left. With the cover test the right eye shows a greater deviation than the left, and both eyes show less deviation on looking to the right than on looking to the left. It seems, therefore, that the condition should now be regarded as a spasm of the right internus rather than a paralysis of the right externus. Such cases are said to be due to contracture of the antagonist muscle (in this case, the right internus); when the paralysis clears up this contracture is too great to be overcome, and a concomitant squint results.

DISCUSSION

Dr. WILLIAM ZENTMAYER: What has occurred in Dr. Reese's interesting case is probably what occurs in most cases of acquired palsy of an ocular muscle when recovery is delayed or does not take place, and explains the fact that in such cases the diplopia is lost. Probably the spasm first affects the synergic and later the antagonistic muscle. For instance, in a case of paralysis of the superior rectus, the synergic muscle, the inferior oblique, is first affected and for a time gives the symptoms of bilateral paralysis of the superior rectus. Later a spasm of the inferior rectus occurs.

BILATERAL RETINAL GLIOMA TREATED BY RADIATION: A CLINICAL AND HISTOLOGIC REPORT. DR. A. G. FEWELL and DR. W. E. FRY.

This paper was published in full in the August 1935 issue of the ARCHIVES.

RETINOBLASTOMA (PRELIMINARY REPORT). DR. C. E. G. SHANNON.

Examination of the right eye of a male baby, 18 months old, gave entirely negative results. In the left eye, however, the pupil was moderately dilated and immobile. The typical grayish-white reflex was first seen by the mother a month previously. Examination revealed a grayish-white lobulated growth occupying the greater part of the vitreous chamber with several small vessels coursing over its surface. The tension

was 25 mm. of mercury. A tentative diagnosis of retinoblastoma was made, and removal of the eye was recommended and carried out. Microscopic slides prepared and examined by Dr. Joseph Waldman verified the diagnosis.

Other conditions resembling retinoblastoma should be borne in mind when making the diagnosis, such as remains of the hyaloid artery, retention of the posterior sheaf of the lens, exudative choroiditis, tuberculoma, gumma and sarcoma of choroid.

DISCUSSION OF PAPERS BY DRS. FEWELL AND FRY AND SHANNON

DR. J. ROBERT ANDREWS: I think that in the discussion of these two papers we should take into consideration the radiosensitivity of the various structures of the eye. In general, the eyelids and conjunctiva are more sensitive than cutaneous structures. Next in the order of sensitivity are the cornea, iris and ciliary body. Irradiation of these structures may result in conjunctivitis, keratitis and uveitis. The crystalline lens occupies a peculiar position in view of the fact that lenticular opacities may result from the effect of protracted application of radiation, although there may be no permanent damage to any of the other ocular structures. The retina of an adult eye can almost never be affected by doses of external radiation which do not exceed the tolerance of the cutaneous and other structures which lie between the source of radiation and the retina.

External irradiation of the eye for diseases of the retina, and more especially for tumors of the retina, is followed by little success, as in the case reported by Drs. Fewell and Fry. The patient received in the course of about one year a dose of x-rays of the order of from 6 to 8 skin erythema units. No evidence of lenticular opacity was found when the eye was removed, although there is no doubt in my mind that such opacities would have resulted had the eye been allowed to remain in the patient. On the other hand, no appreciable response was observed in the retinal tumor during this time, and by microscopic examination nothing was found which could be directly attributable to an effect of irradiation. It is not likely that retinoblastoma will be cured by external radiation alone.

The English are attacking this problem by introducing radium needles directly into the sclera at the site of the tumor. I believe that when the involvement is unilateral the procedure of choice is to enucleate the eye. If the tumor subsequently involves the other eye, and it is desired to make an attempt to preserve sight, such a technic may be employed in the treatment of this eye. Gold radon seeds would probably be preferable to radium needles, as they could be left permanently in situ. External radiation could then be employed to build up the total dose of radiation to such an amount as would be adequate to affect the tumor. Such a policy in the management of these cases requires the greatest cooperation between the radiologist and the ophthalmologist.

It is difficult to speak of the value of postoperative irradiation of the orbits of these patients because there is no method by which the results can be evaluated. I am inclined to the belief that it is of little value.

DR. ALEXANDER FEWELL: I was surprised, considering the rather large dosage of x-rays over a prolonged period of time, to find no lens

changes. I have recently seen the child, who seemed well and was developing normally. There was no visible evidence of metastasis.

DR. WILLIAM ZENTMAYER: The Section might be interested to know the subsequent course of the case of bilateral glioma in which I enucleated one eye and implanted a radon seed in the remaining eye. When the child was last seen, the enormously enlarged retinal vessels were somewhat reduced in size, and the growth showed numerous lustrous areas, probably indicating cellular change. In October 1934, Dr. Palmer of Miami, Fla., who referred the case, reported that the vessels and the growth both appeared smaller and that the child's vision had improved.

DR. T. B. HOLLOWAY: Through the courtesy of Dr. Fewell, I had the opportunity of following the case reported. In the first eye removed there were two large masses, and I felt it would be better to use the usual radiation rather than the radon seeds. One of the masses certainly was favorably influenced, but the other continued to increase in size.

Recently another case of this character was observed in my clinic, but the condition was so far advanced that no type of treatment would have been of service. The child has been kept under observation, and up to the present time the other eye has remained healthy.

A COMPARISON OF TONOMETERS FOR THEIR CLINICAL ACCURACY. DR. FRANCIS H. ADLER, DR. GEORGE E. BERNER and DR. GEORGE P. MEYER.

This investigation was carried out (1) to devise an instrument for the testing of tonometers, (2) to compare the readings of different tonometers with actual intra-ocular pressures, (3) to compare the readings of standard tonometers of the same make at different pressures, and (4) to determine factors which cause variations in readings.

The results were:

1. The instrument is essentially an inclined mercury manometer capable of delicate adjustment, from which pressure is transmitted to an enucleated cat's eye through a needle in the eye connected to the manometer with pressure tubing filled with physiologic solution of sodium chloride. The eye, with the cornea vertical, is supported in a brass ring. The tonometer is held in a clamp at the end of a rod which is fastened to the tube of a microscope so that the tonometer can be raised and lowered by operating the coarse adjustment of the microscope.

2. Schiötz, McLean and Gradle tonometers were found to be sufficiently accurate for clinical purposes. Between the pressures of 20 and 40 mm. of mercury there was rarely a difference of more than 4 mm. between the actual pressure and the tonometer reading. One Bailliart tonometer was tested and found entirely inaccurate. McLean tonometer readings of pressures between 20 and 30 mm. were 3 mm. higher than Schiötz tonometer readings and those of pressures between 30 and 40 mm. were 4 mm. higher than Schiötz.

3. Four Schiötz instruments were taken at random and compared. Between the pressures of 20 and 30 mm. there was no more than 3 mm. difference in readings. At higher pressures greater inaccuracies devel-

oped, but the inaccuracy for the particular instrument was constant and, when known, could be allowed for in the readings.

4. For accurate readings, the plunger of the tonometer must be absolutely clean, the foot-plate must rest smoothly on the cornea, approximately on the center, and the tilt of the instrument must not be more than 15 degrees. Weights for the Schiötz instrument should be selected so that the pointer reads between 3 and 7 on the scale.

DISCUSSION

Dr. George P. Meyer, Camden, N. J.: To illustrate the disparity in readings, a study of the findings of the Schiötz and McLean tonometers was made during the past week at the Wills Hospital through the kindness of Dr. Phillips. The observations made were incorporated in the slide presented. As noted, the McLean tonometer readings were without exception higher than the Schiötz, and deviations were greater in the higher tonometric ranges. This may be accounted for by the technic ordinarily employed at the Wills Hospital, of making readings on the Schiötz tonometer correspond to the range from 5 to 10 rather than to that between 3 and 7, where the readings probably approach accuracy more closely.

Dr. T. B. Holloway: I should like to speak of the care exercised in the manufacture of the early Schiötz instrument, and to question whether this has been carried out as a routine by different manufacturers in more recent years. Of course, there are several factors that may influence the final clinical reading, and it is interesting, and not a little disconcerting at times, to note the variation in tension obtained by different clinicians with different instruments of the same type. I think the careless method of taking the tension with the patient sitting in a chair should be condemned. In regard to the graphs shown, it is interesting to note the greater variation in the higher ranges. I should like to know whether the various readings were made with the same weight or different weights and whether the same eye or different eyes were used. It is thought that certain parts or phases of every technic and experiment are attended by greater opportunities for error than other parts or phases; therefore, I should like to ask whether the variations in the higher readings might be accounted for in this way.

Dr. Francis H. Adler: We used the weight which would bring the reading of the pointer between 3 and 7 on the scale. If the first weight used brought the reading above or below this level a second weight was used and the reading with that taken. The same eye was used throughout a series of readings, but a different eye was used for each series. The pressure in the eye was set at a low level and increased with each series. There are, of course, imperfections in the technic. Fluid will leak out of the eye from the cut vessels, even though the connection with the needle through the optic nerve is perfect, so that when working at a high intra-ocular pressure the reading must be taken immediately after the stop-cock connecting the eye with the manometer is closed. Discrepancies in the higher readings are probably due to imperfections of this sort. One must keep in mind the fact that we are not actually measuring intra-ocular pressures but a resultant of many forces, one of which is the elasticity of the cornea.

March 21, 1935

J. MILTON GRISCOM, M.D., *Chairman*

A. G. FEWELL, M.D., *Clerk*

VOLUNTARY CONTROL OF ACCOMMODATION: TWO CASES. DR. WILLIAM ZENTMAYER.

A young man of 25 had a low degree of hyperopia. In childhood he was left-handed and wrote and drew upside down. Dr. Clarence Patten made a diagnosis of (1) hereditary endocrine disturbance and (2) psychoneurosis of the anxiety neurosis type. The patient was able to accommodate at will for distance to the power of 5.50 diopters. At the same time one eye converged about 10 degrees. With the ophthalmoscope the fundus was seen with a +2 diopter sphere, and this was immediately converted into a myopia of 3 diopters at will. With the biomicroscope a change in the curvature of the lens could be readily seen during this voluntary change of accommodation. Thus, there is apparently a tendency to spasm of accommodation in infinity accompanied by excessive convergence, though the possibility of the reverse sequence cannot be entirely excluded; that is, the primary anomaly is an excess of convergence accompanied by excessive innervation of accommodation.

A girl of 14 with a high compound hyperopic astigmatism could manifest her total hyperopia for distance. She was unable to maintain a near point sufficiently long for study. It required a +2.50 diopter lens in addition to her correction for distance to obtain a near point of 23 cm. She could, however, with effort obtain a near point of 9 cm. for a brief time only. With correction she had an exophoria of 17 degrees for near. Fusion was absent. In this case there is a subnormal impulse toward accommodation as well as a controlled accommodation. The existence of a high exophoria for near with the refractive error corrected is due to lack of innervation of the interni as a result of the relaxation of accommodation. The esotropia present without correction of the hyperopia is the ordinary accommodation squint.

VOLUNTARY CONTROL OF ACCOMMODATION FOR DISTANCE. DR. WARREN S. REESE.

This patient's condition corresponds to that of Dr. Zentmayer's patients. On looking into the distance without his glasses he reads 6/60 with each eye. If told to read distinctly he can, however, read 6/6 without nipping his lids or changing his eyes except that the right eye turns in and his pupils contract. He has hyperopia of +3.50 diopters and wears full correction. The condition is of interest in that it illustrates the profound effect of accommodation on convergence. With his glasses on, he has practically orthophoria. He has worn glasses since childhood and dates practically all of his symptoms from the appearance of his gastric ulcer one year ago.

DISCUSSION

DR. ALFRED COWAN: From Dr. Reese's description, it seems to me that his case and that of Dr. Zentmayer are identical. I thought that the increased accommodation was the result of convergence, not that the convergence was the result of accommodative effort. On examination of Dr. Zentmayer's patient I found a total accommodation of 10 diopters, while at 6 meters the greatest effort he could make disclosed only 5 diopters, and this could be obtained only while he converged. Dr. Reese's case was of the same type. I examined Dr. Zentmayer's patient with the slit lamp. In order to eliminate movement during convergence, I had him sight along a string which he stretched from his eye to a distance of 6 meters. He could sight one eye or the other directly along this string while the other converged. The increase in curvature of the anterior surface of the lens seemed to be even all over. No irregularity could be seen, such as a greater increase in the central portion of the lens and relative flattening around the periphery.

DR. H. MAXWELL LANGDON: "Facultative hyperopia" is not the term which should be used to describe the type of error of refraction in Dr. Zentmayer's case. It seems to represent, according to Tscherning's classification, that subdivision which is called "relative hyperopia," in which the hyperopia is overcome only by a very strong effort of the accommodation, which is aided by an overconvergence. This seems to be the condition which exists in Dr. Zentmayer's case.

NITROCELLULOSE OF LOW VISCOSITY USED AS AN EMBEDDING MEDIUM FOR EYES THAT ARE TO BE SECTIONED. DR. W. E. FRY.

This article was published in full in the September issue of the ARCHIVES, p. 482.

SHOEMAKER'S MODIFICATION OF THE MOTAIS OPERATION FOR BILATERAL CONGENITAL PTOSIS OF THE LIDS. DR. HUNTER W. SCARLETT.

The Shoemaker modification of the Motais operation for ptosis of the lid consists of isolating, but not detaching any portion of, the superior rectus muscle, putting a double-armed suture through the tendon, bringing the latter up to and attaching it to the superior border of the tarsus. The superior border of the tarsus is exposed by making a through and through incision in the lid at the level of the upper border. After the tendon is sutured to the tarsus, the suture is brought out on the skin surface of the lid about 4 or 5 mm. above the ciliary border and tied around a small piece of rubber tubing.

INTRACAPSULAR CATARACT EXTRACTION BY THE KNAPP METHOD, AS COMPARED WITH THE CLASSIC PROCEDURE: A CLASSIC REPORT. DR. LEIGHTON F. APPLEMAN.

This paper was published in full in the August 1935 issue of the ARCHIVES, p. 249.

MUCOUS MEMBRANE GRAFT FOR SYMBLEPHARON: PEDICLE FLAP BLEPHAROPLASTY. DR. EDMUND B. SPAETH.

Dr. Spaeth exhibited motion pictures to show the procedure.

DISCUSSION

DR. GEORGE H. CROSS, Chester, Pa.: I exhibited a patient before this society on Jan. 18, 1934, with symblepharon and ankyloblepharon of both eyes corrected by means of epidermal skin grafts using a new type of silver conformer, seventeen thousandths of an inch (0.043 cm.) thick. I like silver conformers best, probably because they can be modified to suit the individual case. Why take a graft from inside the mouth when the available area is so small compared with the arm or leg, practically an unlimited area? An epidermal graft can be obtained as thin as tissue paper, while Dr. Spaeth in his pictures showed scraping and cutting to remove excess tissue from the mucous graft to make it available for use, and even then it was thick. Dr. de Schweinitz will remember when he was in charge of the eye work in the Army during the World War that he saw many successful grafts which were punctured full of holes to allow serum and blood which had collected beneath the graft to ooze through and prevent separation of the graft from its bed. The important factor in a successful graft is proper pressure, obtained by applying a tight elastic bandage.

DR. T. B. HOLLOWAY: In several of these cases I have used epithelial grafts and a stent conformer with two perforations at each end. Sutures were inserted through the whole thickness of the lid. I thought in some respects a mucous membrane graft might be better, but I have never used one because I thought its use might prove more difficult. I have never used a metal or glass conformer.

DR. EDMUND B. SPAETH: Relative to the use of epidermal and mucous membrane, it is not more difficult to use one than the other. I have felt that no matter how thin the epidermal graft, it is never wholly satisfactory, for the patient has a resultant chronic low grade conjunctivitis, and this is not present with the mucous membrane graft. Naturally, this matter is of importance only in the presence of a normal eyeball.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

March 18, 1935

WEBB W. WEEKS, M.D., *Chairman*

W. GUERNSEY FREY JR., M.D., *Secretary*

EVALUATION OF ORTHOPTIC TRAINING IN THE TREATMENT OF SQUINT. DR. WILLIAM THORNWALL DAVIS.

The accommodative squint seems to be the most difficult in which to obtain improvement by orthoptic training alone. There is no deviation of the visual axes when accommodation is fully relaxed. Therefore if one does not fully stimulate the accommodation by objects or pictures of interest to the child the true angle of deviation is not manifest, and the measurement one obtains is erroneous.

It should be the desire of the ophthalmologist to cure a squint without the use of glasses and before the school age. Therefore orthoptic training should be pushed with energy and determination, and the cure completed by surgical operation when necessary. One must be careful in prescribing orthoptic training in those cases in which a vertical is combined with a lateral deviation. We may create a desire for fusion which cannot be attained, and diplopia results, or fusion may be attained only with extreme effort and discomfort. One should recognize the type of squint and note the previous treatment. The time to operate must be determined by study of the individual case. Three to six months of orthoptic treatment should be the maximum. If cure is not obtained, surgical correction should be performed and the child given postoperative orthoptic treatment.

Measuring squint by the method of Dr. James Watson White is invaluable, and, unless this is practiced, one may overlook a vertical deviation. Measuring with the cover test and the use of prisms in six cardinal fields, at the same time stimulating accommodation, is essential to the study of the case. When vertical deviations are present they materially change the prognosis and in some cases permit only a cosmetic cure.

In the phorias orthoptic training is of value, particularly with the use of the synoptophore and in that form of esophoria due to divergence insufficiency and exophoria due to convergence insufficiency.

RELATION OF ORTHOPTIC TRAINING TO THE SURGICAL TREATMENT OF CONCOMITANT STRABISMUS. DR. AVERY DEH. PRANGEN.

Orthoptic training seems to be the connecting link between the cosmetic operation and restoration of binocular function. There is at present a revival of this form of treatment for strabismus and heterophoria. For ten years simple methods of orthoptic treatment have been used in a primitive fashion in selected cases. In attempting to evaluate successes and failures in the light of recent advances, two things stand out: First, the fairly large number of successful results demonstrate that orthoptic training is worth while, and, second, the poor results point out that, by employing more efficient methods and better apparatus, the percentage of successful results can be increased materially.

Inasmuch as orthoptic training is closely related to physiology, psychology and pathology, and to surgical treatment, it seems to belong in the sphere of the practice of medicine, and particularly in the practice of ophthalmology. The ophthalmologist, however, is busy and must have assistance. Maddox, Berens and Hardy have solved this problem by the development of carefully trained technical workers who carry out the treatment under the supervision of the ophthalmologist.

Touching briefly on the pitfalls and objectives of orthoptic training, one should be warned chiefly against macular suppression and false projection. The former, which usually is referred to as amblyopia ex anopsia, is probably in the nature of a suspension or inhibition of vision and, in many cases, it can be overcome if proper occlusion is persistently carried out. False projection or retinal incongruity also must be overcome or avoided. In other words, the eyes must be watched while they are undergoing training, to be sure that the fovea rather than some

extrafoveal point of the deviating eye is being stimulated. The objective of the treatment, then, becomes the overcoming of suppression, the avoidance of false projection, the development of simultaneous macular perception, fusion with amplitude and, finally, stereopsis.

The question of when to operate naturally arises. The age of the patient no longer seems to be the determining factor. With modern conditions of differential diagnosis and improved instruments and operative procedures, operation may be carried out safely at any age after 3 years. One must depend on the degree and nature of the strabismus, the condition of the visual apparatus and the response or lack of response of the latter to training. Failure to respond in a reasonable length of time (from six months to one year) to proper occlusion, accurate refraction and intensive orthoptic training seems to be the chief indication for operation. Lack of availability of the patient for training or the presence of a high degree of squint seem to indicate early operative measures that would put the eyes in a position more favorable to spontaneous cure or to successful training.

Reviewing the relation of orthoptic training to operation, the former should be tried in all cases in which it is feasible and as soon as vision in the two eyes is compatible with fusion (from 6/15 to 6/12) in order to determine whether or not operation is necessary. In the light of present opinion, alternating strabismus can be successfully treated, although in a rare case of congenital alternating strabismus the patient apparently does not have any faculty of fusion. As a preparation for operation, all investigators seem agreed that orthoptic training is essential. Certainly, the ability to possess good vision and some degree of fusion seems to insure a much brighter prospect for successful operation. The stage of disorganization which follows operation seems to be the ideal time to employ orthoptic training. This time, perhaps above all others, should be the time to urge the eyes on to a condition of phoria, and from there to a real cure. Although false projection runs high among the alternators (Pugh), it might be that, if more of them were intensively trained after operation, the results would be surprisingly good.

DISCUSSION

DR. LE GRAND H. HARDY: I do not feel so hopeless as Dr. Davis regarding the vertical deviations, and I do not believe any one can foretell with accuracy what their outcome will be, either with respect to surgical intervention or orthoptics. I feel it is one's duty to one's patients to utilize each form of therapy in the attempt to establish or reintegrate their binocular functions. To have seen only one patient with as much as 20 prism diopters of hyperphoria or hypertropia acquire comfortable coordinated control is an impressive experience which cannot easily be dismissed from the mind.

My experience and that of my associates with squints of accommodative type nearly parallels that of Dr. Prangen in that such squints have not been found more difficult to handle. This is no doubt due to a difference in the interpretation of what constitutes an accommodative type of squint. The accommodative type, as we understand Dr. Davis' description, occurs only rarely in our experience. Possibly we have not sufficiently utilized his method of measurement to bring out all the

effects of accommodation. In any case, it seems logical to us to attempt the dissociation of the accommodation-convergence relationship, which is one of the bases of orthoptics.

I think it is unfair to a meritorious method to pass adverse judgment on the basis of a training given once a week. This, to my mind, is not orthoptic training. One would not expect to become adept quickly in music, art, shorthand or surgery if such slight attention were given to instruction and practice. Following graduation one might expect to maintain a high grade of performance with less practice, but the learning of a subject involving motor coordinations requires more assiduous application. Consequently, we require at least two, if not three, visits per week, and these may be supplemented by home training if false projection has been eliminated.

DR. CONRAD BERENS: As Dr. Prangen and Dr. Davis have pointed out, it is evident that the most important field for orthoptic training is in the treatment of heterophoria, because second or third grade vision is usually present. Therefore, it is necessary only to increase the amplitude of fusion and in some cases to attempt to dissociate partially accommodation and convergence.

The treatment of heterotropia presents many difficulties, some of which are recognized and others of which may not be apparent. If one attempts to train young children, in whom this work is sometimes most effective, psychologic factors and lack of intelligence and cooperation are often so great a handicap that the work is useless. Amblyopia presents a serious problem. Although amblyopic patients may develop a certain amount of binocular vision, the result is often disappointing and constant training is required in order to maintain the improvement.

The importance of aniseikonia in heterotropia and heterophoria is becoming more apparent. A patient referred to me by Dr. Wheeler and presented before the section of ophthalmology by Dr. Bielschowsky lately had five operations, but continued to have serious diplopia. The correction of 11 per cent overall aniseikonia and 4.5 per cent meridional aniseikonia apparently permitted fusion, although he could not fuse with a red glass or with red and green spectacles, and the screen test apparently demonstrated that he was not using his right eye. In spite of these findings, the patient insisted that after fusion was broken the images fused and diplopia was no longer present. Apparently he had a prism divergence of 3 diopters for 6 meters and 8 diopters for 25 cm., and a prism convergence of 5 diopters for 6 meters and 6 diopters for 25 cm. Professor Ames told me, when questioned, that orthoptic training increases the ability to overcome aniseikonia.

Dr. Davis discussed the question of the duration of orthoptic training. There have been some patients with alternating squint who showed no improvement after a year's training; however, satisfactory binocular vision developed later. Although knowledge of orthoptic training has increased in the last few years, there is much to be learned through careful research. We have been guilty of giving a child a stereoscope with a box of cards with no instructions; we have given long directions which were unintelligible and could not be used at home, and we have told patients to cover an eye for an hour a day and have expected to obtain good results. The more we know of orthoptic training the more

we believe that it should be done under supervision, which is especially true when patients have false projection. They should have well established second grade binocular vision before they are permitted to train at home. Of course, I do not mean that amblyopic eyes should not be trained during this period.

Orthoptic training must be correlated with careful clinical work, study of the psychologic factors, improved methods in physiologic optics and especially studies of aniseikonia if one is to reduce the number of patients who cannot be benefited and to know when to prescribe and when to discontinue orthoptic training.

Dr. Joseph I. Pascal: From the papers presented tonight it seems that there is a unanimous opinion that orthoptic training is primarily suitable to young children. It is true that this view is prevalent in both the United States and England. But it is interesting to note that in France there is a school of thought which holds exactly the opposite view. This school, headed by Dr. Cantonnet of the Laënnec Hospital in Paris, maintains that the best age for the orthoptic treatment of squint is between 7 and 35 years. They teach that one may expect better results with an adult of 20 than with a child of 7. In fact, they have relatively little use for training children under 7.

It would take too long to go into the reasons for this view of Dr. Cantonnet and his co-workers, but it may be added that their teaching is based on many years of experience in orthoptic training. Orthoptic training in fact had its start in France with Javal in the nineties of the last century. Regular training centers for orthoptic treatments were first established in France. The oldest and largest of these is the one established by Dr. Remy in 1901 in Professor Lapersonne's clinic of the Hôtel-Dieu in Paris. The French, therefore, have had a much longer period of experience with orthoptic training, and their view, even though contrary to the one generally held here, is worthy of mention and critical examination.

Book Reviews

Eighth Annual Report of the Giza Memorial Ophthalmic Laboratory, Cairo. Price, 25 piasters. Pp. 168, with 9 plates and 36 illustrations in black and white. Cairo: Schindler's Press, 1934.

The eighth annual report presents a record of the administration of the Giza Memorial Ophthalmic Laboratory and of the scientific work accomplished during 1933. It is arranged in four sections as follows:

1. *Postgraduate Education.*—The usual course of lectures on medical and surgical ophthalmology for graduates in medicine desirous of entering the ophthalmic service of the department of health was given in April and October. Special attention was devoted to the features of ophthalmic practice peculiar to Egypt.

2. *Pathologic Section.*—The laboratory received five hundred and twenty-three pathologic specimens for examination from the forty-three permanent and fourteen traveling Egyptian Government Ophthalmic Hospitals. Material of particular importance is described in detail and illustrated with photographs. Specimens from the conjunctiva were of unusual interest and demonstrated blastomycosis, schistosomiasis, leproma of the limbus and streptotrichosis of the conjunctiva.

In this section is a study concerned with climate and the seasonal incidence of acute ophthalmias in which the two periods of maximum incidence of Koch-Weeks conjunctivitis and the height of the epidemic of gonoccocic conjunctivitis are shown to coincide with the two principal fly-breeding seasons.

3. *Clinical Section.*—A case of onchocerciasis of the macula is described. No determinative examination of the nematode could be made, but it was probably Onchocerca volvulus. A case of chronic unilateral gonococcic conjunctivitis which resisted treatment for four months is reported.

4. *Research Section.*—Wilson has been unable to isolate Bacterium granulosis in cases of Egyptian trachoma, although Olitsky and Tyler reported successful isolation in four of eleven cases. Shortly after isolation these strains were used to inoculate three human subjects, without result. Wilson concludes that this bacterium does not play an etiologic rôle.

Stewart has continued the study of the Prowazek-Halberstaedter body and concludes that these bodies are not associated with pure trachoma but with trachoma complicated by bacterial infection of the conjunctiva or face. He describes experimental trachoma in monkeys and considers an experiment positive only when the follicles appear about the twentieth to the thirtieth day and cover the whole conjunctiva of the upper fornix. He finds monkeys of the two genera Papio (baboons) and Lasiopyga (grivets) completely susceptible and most other monkeys only irregularly so. From experiments in transmission he concludes that the trachoma virus survives from three to four hours at room temperature in saline solution or in broth of p_H of from 7.2 to 7.8 and resists repeated centrifugation and grinding. It becomes

inactive quickly in fluids of p_H 6.4 and is killed by a 50 per cent solution of glycerin of p_H 7.6 at 37 C. in twenty-four hours. Filtrates passed through Berkefeld V and gradocol 0.6 micron A. P. D. filters were not infective.

A slit-lamp study of spring catarrh is reported by Tobgy. He describes an epithelial disturbance which he proposes to call "keratitis epithelialis vernalis." In this condition the surface of the cornea appears as though it had been dusted with flour. There are edema of the epithelial cells and at times exfoliation and vesicle formation. The condition often occurs in attacks associated with severe photophobia, lacrimation and slight ciliary congestion. Other research projects include a partially successful attempt at prophylaxis of trachoma in children of Bahtim village (described in previous reports) by means of antiseptic collyria and studies on xerophthalmia and retinitis pigmentosa.

PHILLIPS THYGESON.

Das supra-vestibuläre System bei den Tieren und beim Menschen. By Dr. L. J. J. Muskens, Amsterdam, Fellow of the Royal Society of Medicine of Great Britain, korrespondierendes Mitglied der Société Neurologique de Paris. Price, 15 gulden. Pp. 557. Amsterdam: N. V. Noord-Hollandsche Uitgevers Maatschappij, 1934.

The relation of balance and orientation, of kinesthesia and tropisms, of reflex ocular motions and their normal and morbid physiology to the nonacoustic labyrinth and its cerebral centers has been a subject of keen interest, experimentation and clinical study ever since physiology has been a science. This monumental work reviews the research of half a century in the comparative and descriptive anatomy, the biology, the evolutionary history and the pathology, experimental and clinical, of the supravestibular system and the correlated cerebral centers and nerve paths. It traces the phylogeny of posture, static and dynamic, of locomotion, equilibrium and orientation and of gravitational reflexes, and analyzes the data of normal and pathologic function and the findings of the clinic and of experimental traumatization, almost uninterruptedly, from invertebrates to man. As the author points out, there is manifest in all medical literature of the past generation or two the desire to bring order into the multitudinous and complex phenomena noted after injury of the brain stem. It is only recently that this desire has become something more than a pious wish. The necessary presupposition, that of a sufficient knowledge of the nerve paths, was in great part lacking. Industrious anatomic and physiologic research, mainly during the last twenty years, has remedied this deficiency. Muskens' work is of more than usual interest not only to physicians, but to biologists, students of comparative anatomy, and neuropathologists as well. Ophthalmologists will find a wealth of instructive material and a gratifying clarity of "physiological logic" in the chapters on binocular fixation, coordination of eye motions and the evolution of this function from the fishes and lower vertebrates upward. There are also chapters on paralyses of fixation, frontal lobe ataxia, forced positions and forced movements and vestibular and optical nystagmus, with, in conclusion, a side glance on such allied topics as vertigo, seasickness, airsickness and caisson disease.

PERCY FRIDENBERG.

News and Notes

EDITED BY DR. JOHN HERBERT WAITE

UNIVERSITY NEWS

Course in Muscles, Northwestern University Medical School.—A course in muscles will be offered at the Northwestern University Medical School from December 2 to 7, inclusive. The course will cover the diagnosis and treatment of concomitant and paralytic strabismus. Dissection of the orbit and typical operations on muscles will be demonstrated on the cadaver. Enrolment will be limited to fifteen students. Complete information regarding registration may be obtained from Dr. Sanford R. Gifford, Northwestern University Medical School, 303 East Chicago Avenue, Chicago.

CORRECTION

In the translation of Professor Filatov's article, entitled, "Transplantation of the Cornea," in the March issue (ARCH. OPHTH. **13**:321, 1935), the word "cadaver" in the last line on page 331 should read "patient."

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Prof. F. de Lapersonne, 217 Faubourg St. Honoré, Paris.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.

International Ophthalmologic Congress

Secretary: Dr. Francisco Poyales, Olozaga 3, Madrid.
Place: Cairo. Time: 1937.

FOREIGN

British Medical Association, Section on Ophthalmology

President: Dr. A. J. Ballantyne, 11, Sandyford Pl., Glasgow, C 3.
Secretary: Dr. J. Ringland Anderson, 108 Collins St., Melbourne.

Ophthalmology Society of Bombay

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

Ophthalmological Society of the United Kingdom

President: Mr. R. Foster Moore, 53, Harley St., London, W. I.
Secretary: Miss Ida Mann, 7, Wimpole St., London, W. I.

Oxford Ophthalmological Congress

Master: Dr. C. G. Russ Wood, Hill House, Abberbury Rd., Iffley, Oxford, England.
Hon. Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.

Royal Society of Medicine, Section of Ophthalmology

President. Dr. Ransom Pickard 31, East Southernhay, Exeter, England.
Secretary: Dr. J. D. Magor Cardell, 27, Weymouth St., London, W. 1.

Société Française d'Ophthalmologie

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris 7è.

Society of Swedish Ophthalmologists

President: Prof. F. Berg, Uppsala, Sweden.
Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö., Sweden.

German Ophthalmological Society

Secretary: Prof. A. Wagenmann, Heidelberg.

Chinese Ophthalmological Society of Peiping

President: Dr. P. H. Liu, Chi-Ming Eye Clinic, Ta Liu Pu Kau, Peiping.
Secretary: Dr. H. H. Feng, Peiping Union Medical College, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

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* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

TSINAN OPHTHALMOLOGICAL SOCIETY

Chairman: Dr. Eugene Chan, Cheeloo University School of Medicine, Tsinan, Shantung.
Place: Cheeloo University School of Medicine. Time: Last Thursday of alternate months.

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. John Green, 3720 Washington Blvd., St. Louis.
Secretary: Dr. Parker Heath, 1553 Woodward Ave., Detroit.
Place: Kansas City, Mo.: Time: May 11-15, 1936.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Wells P. Eagleton, 15 Lombardy St., Newark, N. J.
President-Elect: Dr. Frank E. Burch, 408 Peter St., St. Paul.
Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Louis S. Greene, Washington, D. C.
Secretary-Treasurer: Dr. J. Milton Griscom, 2213 Walnut St., Philadelphia.
Place: Hot Springs, Va. Time: June 1-3, 1936.

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Managing Director: Mr. Lewis H. Carris, 50 W. 50th St., New York.
Place: New York City. Time: Dec. 5-7, 1935.

SECTIONAL

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. James J. Regan, 520 Commonwealth Ave., Boston.
Secretary-Treasurer: Dr. Benjamin Sachs, 483 Beacon St., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. H. G. Merrill, 3245 4th St., San Diego, Calif.
Secretary-Treasurer: Dr. Frederick C. Cordes, 384 Post St., San Francisco.
Place: Del Monte, Calif. Time: Spring, 1936.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Francis A. Brugman, 509 Olive St., Seattle.
Secretary-Treasurer: Dr. Noble Dick, 1115 Terry Ave., Seattle.
Time: 8 p. m., third Tuesday of each month, except July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. W. R. Fringer, 228 S. Main St., Rockford, Ill.
Secretary-Treasurer: Dr. W. H. Elmer, 321 W. State St., Rockford, Ill.
Place: Rockford, Ill., Janesville or Beloit, Wis. Time: Third Tuesday of each month.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Robert Griswell, 707 Washington Ave., Bay City, Mich.
Secretary-Treasurer: Dr. W. K. Slack, 308 Eddy Bldg., Saginaw, Mich.
Place: Saginaw, Mich., or Bay City, Mich. Time: Second Tuesday of each month, except July and August.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. L. H. Hohf, Yankton, S. D.
Secretary-Treasurer: Dr. J. C. Decker, Francis Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. William A. Wagner, 914 American Bank Bldg., New Orleans.
Secretary: Dr. O. M. Marchman, Medical Arts Bldg., Dallas, Texas.
Place: St. Louis. Time: November 1935.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. F. B. Fralich, 202 S. Main St., Ann Arbor, Mich.
Secretary-Treasurer: Dr. A. S. Barr, 201 S. Main St., Ann Arbor, Mich.
Time: Third Thursday of alternate months.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Claude W. McKee, 229 S. Main St., Greensburg.
Secretary-Treasurer: Dr. C. W. Beals, 41 N. Brady St., DuBois.
Place: Indiana. Time: October 1935.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY

President: A presiding officer is selected for each meeting alternately until all members have served.
Secretary: Dr. Edna M. Reynolds, 227, 16th St., Denver.
Place: Capitol Life Building, Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. George B. Garlick, 144 Golden Hill St., Bridgeport.
Secretary-Treasurer: Dr. Shirley H. Baron, 309 State St., New London.
Time: May, November.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. B. H. Minchew, 701 Elizabeth St., Waycross, Ga.
Secretary-Treasurer: Dr. Edward S. Wright, 1001 Medical Arts Bldg., Atlanta, Ga.
Place: Savannah. Time: May 12-15, 1936.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. J. R. Dillinger, French Lick.
Secretary: Dr. Frederick V. Overman, 705 Hume-Mansure Bldg., Indianapolis.
Place: Martinsville. Time: April 8, 1936.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. F. W. Dean, 532, 1st Ave., Council Bluffs.
Secretary-Treasurer: Dr. O. L. Thorburn, 213½ Main St., Ames.
Place: Council Bluffs. Time: Nov. 7, 1935.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. John W. Orr, 503 S. Saginaw St., Flint.
Secretary: Dr. D. R. Heetderks, 26 Sheldon Ave., S. E., Grand Rapids.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. E. Binger, 350 St. Peter St., St. Paul.
Secretary-Treasurer: Dr. Walter E. Camp, Medical Arts Bldg., Minneapolis.
Place: St. Paul. Time: May 1936.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. George A. Lewis, Roundup.
Secretary: Dr. A. W. Morse, Phoenix Bldg., Butte.
Place: Billings. Time: February 1936.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY, OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. C. Coulter Charlton, 124 S. Illinois Ave., Atlantic City.
Secretary: Dr. H. L. Harley, 124 S. Indiana Ave., Atlantic City.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. John F. Fairbain, 925 Delaware Ave., Buffalo.
Secretary: Dr. Walter S. Atkinson, 168 Sterling St., Watertown.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Trygve Oftedal, 55½ Broadway, Fargo.
Secretary-Treasurer: Dr. F. L. Wicks, 514 6th St., Valley City.
Place: Jamestown. Time: May 1936.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. Nathan Bolotow, 108 Waterman St., Providence.
Secretary and Treasurer: Dr. Gordon J. McCurdy, 122 Waterman St., Providence.
Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Josiah E. Smith, 60 Meeting St., Charleston.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. W. Potter, 601 Walnut St., Knoxville.
Secretary-Treasurer: Dr. W. D. Stinson, 248 Madison Ave., Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. T. E. Fuller, 100 W. Board St., Texarkana, Texas.
Secretary: Dr. O. M. Marchman, 1719 Pacific Ave., Dallas.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. William Stookey, 54 E. South Temple St., Salt Lake City.
Secretary-Treasurer: Dr. T. F. Welsh, 711 Boston Bldg., St. Salt Lake City.
Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. Emory Hill, 501 E. Franklin St., Richmond.
Secretary-Treasurer: Dr. George G. Hankins, Medical Arts Bldg., Newport News.
Place: Richmond. Time: May 1936.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. F. O. Marple, First Huntington National Bank Bldg., Huntington.
Secretary: Dr. J. E. Blaydes, First National Bank, Bluefield.

LOCAL

Academy of Medicine of Northern New Jersey, Section on Eye, Ear, Nose and Throat

President: Dr. B. E. Failing, 31 Lincoln Park, Newark, N. J.
Secretary: Dr. A. Russell Sherman, 671 Broad St., Newark, N. J.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

Atlanta Eye, Ear, Nose and Throat Society

President: Dr. Herschel Crawford, 478 Peachtree St., N. E., Atlanta, Ga.
Secretary: Dr. Stacy C. Howell, 384 Peachtree St., N. E., Atlanta, Ga.
Place: Academy of Medicine, 13 Queen's Park. Time: 8 p. m., last Thursday of each month.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. William M. Rowland, 906 Cathedral St., Baltimore.
Secretary: Dr. Mary L. Small, 18 W. Read St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

Brooklyn Ophthalmological Society

President: Dr. John H. Bailey, 855 St. Marks Ave., Brooklyn.
Secretary-Treasurer: Dr. George Freiman, 703 Grand St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. Thurber LeWin, 112 Linwood Ave., Buffalo.
Secretary-Treasurer: Dr. I. J. Koenig, 40 North St., Buffalo.
Time: Second Thursday of each month.

Chicago Ophthalmological Society

President: Dr. Robert B. Blue, 25 E. Washington St., Chicago.
Secretary-Treasurer: Dr. Thomas D. Allen, 122 S. Michigan Ave., Chicago.
Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cleveland Academy of Medicine, Section of Ophthalmology and Otolaryngology

Chairman: Dr. A. D. Ruedemann, 2020 E. 93d St., Cleveland.
Secretary: Dr. Fred W. Dixon, 1029 Rose Bldg., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

Cleveland Ophthalmological Club

Chairman: Dr. A. B. Bruner, 629 Euclid Ave., Cleveland.
Secretary: Dr. M. W. Jacoby, Hanna Bldg., Cleveland.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. John Milton Griscom, 2213 Walnut St., Philadelphia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. F. W. Thomas, 327 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. H. D. Emswiler, 370 E. Town St., Columbus, Ohio.
Place: Athletic Club. Time: First Monday of each month.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. F. H. Newton, Mercantile Bldg., Dallas, Texas.
Secretary: Dr. Maxwell Thomas, 1719 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

DES MOINES ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month, September to May.

DETROIT OPHTHALMOLOGICAL CLUB

Chairman: Members rotate alphabetically.
Secretary: Dr. Raymond S. Goux, David Whitney Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

EASTERN NEW YORK EYE, EAR, NOSE AND THROAT ASSOCIATION

President: Dr. A. W. Greene, 148 Barrett St., Schenectady.
Secretary-Treasurer: Dr. Joseph L. Holohan, 317 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

FORT WORTH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. T. L. Goodman, 602 W. 10th St., Fort Worth, Texas.
Secretary-Treasurer: Dr. Van D. Rathgeber, 1012 Medical Arts Bldg., Fort Worth.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

GRAND RAPIDS EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. John H. McRae, 26 Sheldon Ave., S. E., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Robert G. Laird, 307 Metz Bldg., Grand Rapids, Mich.
Place: Various local hospitals. Time: Third Thursday of alternating months. September to May.

HOUSTON ACADEMY OF MEDICINE, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. R. M. Hargrove, 1202 Esperson Bldg., Houston, Texas.
Secretary: Dr. J. C. Dickson, 1617 Medical Arts Bldg., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. J. C. Daniel, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. B. Davis, 1101 Grand Ave., Kansas City, Mo.
Secretary: Dr. Byron Black, Professional Bldg., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

Chairman: Dr. Clyde E. Harner, 110 Pine Ave., Long Beach, Calif.
Secretary-Treasurer: Dr. Paul T. Southgate, 704 Professional Bldg., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

Los Angeles Society of Ophthalmology and Oto-Laryngology

President: Dr. Walter R. Crane, 756 S. Broadway, Los Angeles
Secretary-Treasurer: Dr. Pierre Viole, 1930 Wilshire Blvd., Los Angeles.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd., Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

Louisville Eye, Ear, Nose and Throat Society

President: Dr. E. A. Leggett, 614 Breslin Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. J. E. Craddock, 604 Breslin Bldg., Louisville, Ky.
Place: Jewish Hospital. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

Medical Society of the District of Columbia, Section of Ophthalmology and Otolaryngology

Chairman: Dr. Arthur M. Zinkham, 815 Connecticut Ave., Washington.
Secretary: Dr. E. J. Cummings, 1835 I St., N. W., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

Memphis Society of Ophthalmology and Otolaryngology

Chairman: Each member, in alphabetical order.
Secretary: Dr. R. O. Rychener, 130 Madison Ave., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

Milwaukee Oto-Ophthalmic Society

President: Dr. J. J. Brook, 231 W. Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. Herbert G. Schmidt, 238 W. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6 p. m., second Tuesday of each month.

Montgomery County Medical Society

Chairman: Dr. W. J. Blackburn, 663 Reibold Bldg., Dayton, O.
Secretary-Treasurer: Dr. F. J. Driscoll, 986 Reibold Bldg., Dayton, O.
Place: Van Cleve Hotel. Time: 6:30 p. m., bimonthly, first Tuesday from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. J. A. MacMillan, 1410 Stanley St., Montreal, Canada.
Secretary: Dr. A. L. Guertin, 410 Sherbrooke St., West, Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Wesley Wilkerson, Bennie Dillon Bldg., Nashville, Tenn.
Secretary-Treasurer: Dr. Hale Cullom, Bennie Dillon Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to June.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. R. H. Fisher, Chess and Checker Club, New Orleans.
Secretary-Treasurer: Dr. H. F. Brewster, 837 Gravier St., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. John H. Dunnington, 30 W. 59th St., New York.
Secretary: Dr. LaGrand H. Hardy, 30 E. 40th St.,, New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. John H. Judd, 107 S. 17th St., Omaha.
Secretary-Treasurer: Dr. W. A. Cassidy, 107 S. 17th St., Omaha
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

PHILADELPHIA COUNTY MEDICAL SOCIETY, EYE SECTION

Chairman: Dr. Charles R. Heed, 1205 Spruce St., Philadelphia.
Secretary: Dr. Sidney L. Olsho, 235 S. 15th St., Philadelphia.
Time: First Thursday of each month from October to May.

PITTSBURGH OPHTHALMOLOGICAL SOCIETY

President: Dr. Edward B. Heckel, 500 Penn Ave., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

PITTSBURGH SLIT-LAMP SOCIETY

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: 121 University Pl. Time: Second Monday evening of every month, except June, July, August and September.

RICHMOND OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Samuel M. Cottrell, 116 E. Franklin St., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Frank Barber, 75 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. Laurence Macey, 221 Alexander St., Rochester, N. Y.
Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. Meyer Wiener, 308 N. 6th St., St. Louis.
Secretary: Dr. W. M. James, Metropolitan Bldg., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. William D. Gill, 323 Medical Arts Bldg., San Antonio, Texas.
Secretary-Treasurer: Dr. Frank Steed, Nix Professional Bldg., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

SAN FRANCISCO COUNTY MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Frank H. Rodin, 490 Post St., San Francisco.
Secretary: Dr. Louis F. Morrison, 490 Post St., San Francisco.
Place: Society's Building, 2180 Washington St., San Francisco.
Time: Fourth Tuesday of every month except May, June, July and December.

SHREVEPORT EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. John T. Crebbin, 624 Travis St., Shreveport, La.
Secretary-Treasurer: Dr. J. A. Wilkinson, Medical Arts Bldg., Shreveport, La.
Place: 1240 Texas Ave. Time: 7:30 p. m., first Monday of every month except July, August and September.

SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. S. D. Brazeau, 407 Riverside Ave., Spokane, Wash.
Secretary: Dr. J. B. Stone, 1105 Paulsen Medical and Dental Bldg., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

SYRACUSE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Arnold B. Kauffman, 104 W. Onondaga St., Syracuse, N. Y.
Secretary-Treasurer: Dr. W. J. Werfelman Jr., 725 State Tower Bldg., Syracuse, N. Y.
Place: University Club. Time: Second Friday of each month except June, July and August.

TORONTO ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. Samuel Mortimer Lyon, 122 Bloor St. W., Toronto.
Secretary: Dr. A. Lloyd Morgan, 86 Bloor St., West, Toronto.
Time: First Monday, November to April.

WASHINGTON, D. C., OPHTHALMOLOGICAL SOCIETY

President: Dr. James M. Greear Jr., 1740 M St., N. W., Washington, D. C.
Secretary-Treasurer: Dr. Ernest Sheppard, 927 17th St., Washington, D. C.
Place: Episcopal Eye, Ear and Throat Hospital. Time: 8 p. m., first Monday in November, January, March and May.